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DATA OF HIGH DAMS
IN
INDIA

VOLUME II

BY

SHRI N. D. GULHATI, I. S. E., M. I. E. (Ind.),
SECRETARY

सत्यमेव जयते

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CONTENTS

VOLUME I

Page
Foreword .. .. (v)
CHAPTER I.—Introduction 1
General 1
Physiography of India 1
Climate 4
Temperature 5
Rainfall 6
Glaciers 7
Rivers 7
Earthquakes 12

CHAPTER II.

Standard forms 13
Abbreviations 19
Dams in this volume 19

CHAPTER III.—CAUVERY BASIN

Moti Talav Dam .. .. III.1(i)
Glen Morgan Dam .. .. III.2.(i)
Forebay Upper Bund Dam .. .. III.3.(i)
Forebay Lower Bund Dam .. .. III.4.(i)
Krishnarajasagar Dam .. .. III.5.(i)
Chamarajasagar Dam .. .. III.6.(i)
Mettur Dam .. .. III.7.(i)
Mukurti Dam .. .. III.8.(i)
Markonahally Dam .. .. III.9.(i)
Byramangala Dam .. .. III.10.(i)
Kanva Dam .. .. III.11.(i)

CHAPTER IV.—KISTNA BASIN

Rajaram Dam .. .. IV.1.(i)
Madag Dam .. .. IV.2.(i)
Ekruk Dam .. .. IV.3.(i)
Mayni Dam .. .. IV.4.(i)
Pingli Dam .. .. IV.5.(i)
Matoba Dam .. .. IV.6.(i)
Shirsuphal Dam .. .. IV.7.(i)
Khadakvasla Dam .. .. IV.8.(i)
Nehr Dam .. .. IV.9.(i)
Bhadalwadi Dam .. .. IV.10.(i)
Ashti Dam .. .. IV.11.(i)

CHAPTER IV.—KISTNA BASIN—*contd.* Page

Machkundi Dam .. IV.12.(i)
Koregaon Dam .. IV.13.(i)
Mhaswad Dam .. IV.14.(i)
Bhatodi Dam .. IV.15.(i)
Pathri Dam .. IV.16.(i)
Shetphal Dam .. IV.17.(i)
Vani Vilas Sagar Dam .. IV.18.(i)
Lonavala Dam .. IV.19.(i)
Walwhan Dam .. IV.20.(i)
Siddapur Dam .. IV.21.(i)
Osmansagar Dam .. IV.22.(i)
Shirawta Dam .. IV.23.(i)
Thokerwadi Dam .. IV.24.(i)
Sir Pirajirao Talao Dam .. IV.25.(i)
Himayatsagar Dam .. IV. 26.(i)
Palair Dam .. IV.27.(i)
Lloyd Dam .. IV.28.(i)
Mulshi Dam .. IV.29.(i)
Wyra Dam .. IV.30.(i)
Visapur Dam .. IV.31.(i)
Anjanapur Dam .. IV.32.(i)
Rooty Dam .. IV. 33.(i)
Pendlipakala Dam .. IV.34.(i)
Nandargi Dam .. IV. 35.(i)
Dindi Dam .. IV.36.(i)
Radhanagari Dam .. IV.37.(i)

CHAPTER V.—MINOR BASINS

Periyar Dam .. V.1.(i)
Kodayar Dam .. V.2.(i)
Unkal Dam .. V.3.(i)
Mopad Dam .. V.4.(i)
Tansa Dam .. V.5.(i)
Willingdon Dam .. V.6.(i)
Thippayapalem Dam .. V.7.(i)
Thambraparni Diversion Weir Dam .. V.8.(i)
Thambraparni Dam .. V.9.(i)

VOLUME II

Foreword .. (v)
CHAPTER I.—Introduction .. 1
General .. 1
Physiography of India .. 1

CHAPTER I—*contd.*

Page

Climate .. 4
Temperature .. 5
Rainfall .. 6
Glaciers .. 7
Rivers .. 7
Earthquakes .. 11

CHAPTER II.

Standard form .. 13
Abbreviations .. 19
Dams in this volume .. 19

CHAPTER VI.—GODAVARI BASIN

Waghad Dam .. VI.1(i)
Darna Dam .. VI.2(i)
Ramtek Dam .. VI.3(i)
Khairbanda Dam .. VI.4(i)
Chandpur Dam .. VI.5(i)
Asola Mendha Dam .. VI.6(i)
Jumania Dam .. VI.7(i)
Alair Dam .. VI.8(i)
Ghorajheri Dam .. VI.9(i)
Sarathi Dam .. VI.10(i)
Charakhamara Dam .. VI.11(i)
Badalkasa Dam .. VI.12(i)
Wilson Dam .. VI.13(i)
Royenpally Dam .. VI.14(i)
Bori Dam .. VI.15(i)
Nizamsagar Dam .. VI.16(i)

CHAPTER VII.—MAHANADI BASIN

Tandula Dam .. VII.1(i)
Maramsilli Dam .. VII.2(i)
Kharung Dam .. VII.3(i)
Maniari Dam .. VII.4(i)

CHAPTER VIII.—TAPTI BASIN

Mukti Dam .. VIII.1(i)
Hartala Dam .. VIII.2(i)
Parsul Dam .. VIII.3(i)
Dedargaon Dam .. VIII.4(i)
Chanakpur Dam .. VIII.5(i)
Talwada Dam .. VIII.6(i)

CHAPTER IX.—NARBADA RIVER BASIN

Jubalpore Dam .. IX.1(i)
Jagla Dam .. IX.2(i)

CHAPTER IX.—NARBADA BASIN—contd.

Page
Pariat Dam .. IX.3(i)
Bahori Bund Dam .. IX.4(i)

CHAPTER X.—GANGA RIVER BASIN

Paricha Dam .. X.1(i)
Dhukwan Dam .. X.2(i)
Lachura Dam .. X.3(i)
Nagda Dam .. X.4(i)
Dhobni Dam .. X.5(i)
Pahari Dam .. X.6(i)
Antalwasa Dam .. X.7(i)
Ghori Dam .. X.8(i)
Gangao Dam .. X.9(i)
Kotra Khamba Dam .. X.10(i)
Gorai Canals Upper Storage .. X.11(i)
Tigra Dam .. X.12(i)
Majhgawan Dam .. X.13(i)
Ghagar Dam .. X.14(i)
Khapta Dam .. X.15(i)
Magarpur Dam .. X.16(i)
Barwarlake Dam .. X.17(i)
Borina Upper Dam .. X.18(i)
Amahi Dam .. X.19(i)
Pagara Dam .. X.20(i)
Chandia Nala Dam .. X.21(i)
Mala Dam .. X.22(i)
Jaiwanti Dam .. X.23(i)
Rampur Dam .. X.24(i)
Aunjhar Dam .. X.25(i)
Kekato Dam .. X.26(i)
Aoda Dam .. X.27(i)
Harsi Dam .. X.28(i)

CHAPTER XI.—MINOR BASIN

Russell Konda Dam .. XI.1(i)
Surada Dam .. XI.2(i)
Muwalia Dam .. XI.3(i)

FOREWORD

Data of high dams in India was collected by the Central Board of Irrigation in 1936-39 at the instance of the International Commission on Large Dams. This collection proved useful when after World War II, all administrations in India undertook large scale investigations of multi-purpose projects and many enquiries were received asking for information relating to existing dams in India. These enquiries were complied with, so far as possible, on the basis of the information already collected. At its annual meeting held in November, 1945, the Central Board of Irrigation decided that the entire data of high dams (more than 50 feet high) built so far in India, should be published for general use.

Accordingly a comprehensive standard form was devised and the information already collected in 1936-39 was tabulated. These forms, duly filled in respect of each dam, were sent to the administrations concerned for check and completion. The Board is grateful to the Chief Engineers concerned who very kindly cooperated and made it possible to present this authentic compilation.

The publication is in two volumes, the data of dams have been grouped basin-wise. Volume I relates to dams in the Cauvery, Kistna and adjacent minor basins. These basins include dams in Travancore and Cochin Unions, Mysore, parts of Madras, Hyderabad and Bombay States. Volume II relates to Basins in the rest of India. Information is furnished on all the salient features of a dam and has been grouped under appropriate heads for facility of reference. A copy of the standard form referred to above will be found in chapter II. For facility of reference, the data of each dam has been indexed in accordance with the standard form.

It will be observed that information relating to some features of certain dams has not been filled in. This is because it is not available. The undersigned will be grateful if this information is supplied to him as soon as it becomes available. It will be printed along with data of high dams that may henceforth be built in India. The binding has been so arranged as to make it easy to insert additional data.

The undersigned acknowledges with thanks the great help rendered by Captain P. R. Ahuja, Deputy Secretary and Shri I. K. Mahajan, Technical Assistant, Central Board of Irrigation in the preparation of this compilation.

N. D. GULHATI,
Secretary,
Central Board of Irrigation.

SIMLA, KENNEDY HOUSE ;
February 10, 1949.

CHAPTER I

INTRODUCTION

GENERAL

Irrigation has been practised in India from prehistoric times. Irrigation from storage works likewise is an ancient practice. There are several very old tanks in India, may be a thousand years old or more, which are still functioning fairly efficiently. It is interesting to note that in Mysore State alone, the number of storage works, big and small, exceeds 25,000, and that in the State of Madras 35,000. Similarly there are a large number of storage works in Bombay, Madhya Pradesh and Hyderabad States. Most of the small works were built in very early days and it is mainly during the past hundred years that big State-managed storage projects have been constructed and facilities of irrigation extended to vast areas.

Of the total of over 50 million acres under irrigation in India, storage works account for over eight millions. Three-fourth of the area protected by storage works is confined to Southern India. On the other hand, except for deltaic canals in Madras, gigantic river diversion works exist mainly in Northern India. Why this great diversity in the nature of irrigation works built so far ? The efforts of those responsible for the early development of irrigation works in India were directed naturally to those resources which were easy to exploit. In Northern India, most of the rivers are snow-fed and perennial and river diversion works are, therefore, easy and economical to construct whereas in Southern India, the rivers though swollen during monsoon, have little flow during dry weather. Irrigation in the South is, therefore, possible only by the construction of storage works to ensure assured and regular supplies. In Northern India also with the almost full utilisation of available perennial supplies, several multi-purpose storage projects are now contemplated and some of them are actually under construction.

In this Publication an attempt has been made to compile important engineering data of all high dams built so far in India. It is the intention that similar data of works to be constructed in future will be added to these Volumes as and when it becomes available.

For a proper appreciation and understanding of the information furnished herein, it appears necessary to devote some space to a description of the physical features of the country which determine mainly her rainfall and climate, soil and crops *etc.* A brief account of the geology of the country is also necessary.

PHYSIOGRAPHY OF INDIA

Physiographically India may be divided into four parts. These are the Peninsula proper, the Indo-Gangetic Alluvial Plains, and the Himalayan and associated mountains called the Extra-Peninsula and the Thar Desert. (see Figure 1).

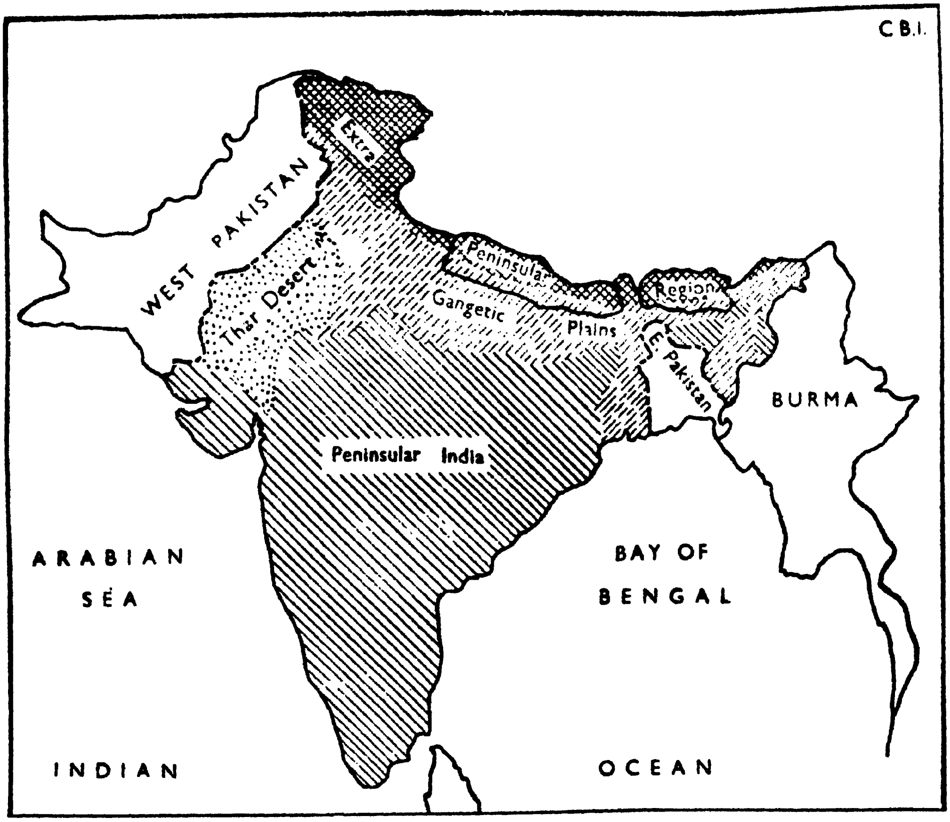

Figure 1 : *Showing physical division of India*

THE PENINSULA

The Peninsula is an ancient land mass, owing its present features to denudation and weathering over long ages. The harder rock masses which have resisted weathering stand-out today as mountains, the softer forming the valleys and plains. It represents a stable block of the earth's crust which has not been affected appreciably by earth movements since Pre-Cambrian times, though it has suffered some faulting and secular movements. It is composed, mainly of ancient crystalline and metamorphic rocks which are, in some places covered by later sediments and lava flows. Since the Pre-Cambrian times, marine rocks were deposited only on their fringes in the Upper Mesozoic and Tertiary times. But fluviatile and lacustrine sediments were formed in the Gondwana era in some places.

Peninsular Mountains

The Peninsular mountains include the Western and Eastern Ghats, Vindhyas, Satpuras, Aravallis and Assam ranges.

The Western Ghats—These form a series of ranges running parallel to the western coast of the Peninsula, the coastal strip to their west being comparatively narrow and in general less than 30 miles wide. In their southern part, from Cape Comorin to Dharwar, they are composed of ancient crystalline and metamorphic rocks, while the lavas of the Deccan form their northern part. In different portions these are called the Anaimalais, Cardamom Hills, Nilgiris and Sahyadris.

The Eastern Ghats—These are a series of rather disconnected ranges stretching from Orissa to the Nilgiris. They comprise the Eastern Ghats of Orissa and the Northern Circars, the Nallamalais, Javadi Hills, Shevaroys and other hills. They are made up of a variety of rocks, gneisses, khondalites, charnockites and schists of igneous and sedimentary origin.

The Satpura and Vindhya Mountains—These are the ranges stretching more or less west to east from the Gulf of Cambay to Bihar. Those to the south of the Narbada are the Satpuras, which extend through the northern part of Madhya Pradesh into Bihar. The mountains to the north of the Narbada are the Vindhyas, and a certain group of sedimentary rocks which go largely into their constitution has been named after them.

The Aravalli Mountains—These are the major mountain ranges of Rajputana trending in a N. E.-S. W. direction from near Delhi in the north to Gujerat in the south. They tend to spread out in the south, one part leading towards the Western Ghats and the other towards the Satpuras of the Madhya Pradesh. The Aravallis are made up of crystalline and metamorphic rocks and, to some extent, of ancient sedimentaries.

The Assam Ranges—The Garo, Khasi, Jaintia and Mikir Hills together make up the mountains of the Peninsular part of Assam. They are composed mostly of ancient gneisses and schists, tapering into a wedge-like mass towards the north-eastern corner.

THE EXTRA-PENINSULA

The Extra-Peninsula is a region of folded mountains of comparatively late age, that is, formed during the Tertiary era. It has been disturbed by earth movements of great magnitude, as the rocks are seen to have been folded, faulted, overthrust and even carried over considerable distances as thrust-sheets or nappes. The topography is very rugged and the rivers are youthful and torrential, actively eroding their courses.

The rocks comprise sediments of all ages representing the whole of the geological column. Accompanying the earth movements there were also igneous intrusions—mainly granitic—on a large scale, these being seen particularly in the Central Himalayan belt.

The Extra-Peninsular ranges include the Himalayas and their continuation westward into Baluchistan on the one hand and eastward into Burma on the other. Individual units will be found to be approximately parts of circular arcs, with varying radii. All have their convex side turned towards India. The arc-like ranges are arranged one behind the other, the curvature increasing with proximity to India.

The Himalaya Mountains—The Himalayas are a series of mountain ranges lying more or less parallel to each other. The different units here are the Hindukush and Karakoram, Kailas Range, Ladakh Range, Zanskar Range, the main Himalayan Range and the mountains of the Sub-Himalayan region. The Himalayas proper comprise four parallel longitudinal zones called respectively (from south to north) the Siwalik Zone of foot-hills, bordering the Indo-Gangetic plains, the Lesser Himalayas or Sub-Himalayan Zone, the Great Himalayas or Central Himalayas containing the high snow-clad peaks, and lastly the Trans-Himalayan Zone. The Siwalik zone consists mainly of sediments of Tertiary age. The Lesser Himalayas are made up of more ancient sediments, which have been very highly disturbed and which often show overthrusts and nappes of great magnitude. The Great Himalayas comprise the same types of sediments, these being profusely intruded by granitic rocks. The Trans-Himalayan region contains fossiliferous marine sediments of various ages laid down in the Tibetan sedimentary zone.

THE INDO-GANGETIC PLAINS

These lie between the Extra-Peninsular region and the Peninsular India and represent a sag or depression in the crust of the earth filled up with alluvium brought down by the rivers from behind. This is the most interesting and important region. The alluvial land of these plains constitutes one of the most extensive and fertile tracts in the world. The alluvial soils of these plains is being cultivated from times immemorial and yet it shows little sign of exhaustion. The rivers flowing through the tract are snow-fed, very active during rainy season and carry enormous detritus load.

THE THAR DESERT

The Thar Desert occupies a very large part of Rajputana. There are no high hills in this region to intercept the South-West Monsoons which pass over it. Structurally this region exhibits characteristics intermediate between the Peninsula and the Extra Peninsular Regions. The rocks show only a little disturbance but marine fossiliferous rocks belonging to the Mesozoic and Tertiary ages are also present. Figure 2 shows the geological features of India.

CLIMATE

India lies partly in the tropical and partly in the sub-tropical regions ; the Tropic of Cancer passes through the Rann of Cutch and the middle of West Bengal *i.e.* almost through the middle of the country. The sub-tropical zone, comprising Rajputana, East Punjab and some Eastern parts of Uttar

Pradesh including Delhi Province, enjoys extreme climate, while the tropical zone is appreciably more equable.

In most parts of the country there are three seasons :

(*i*) Winter : November to March.
(*ii*) Summer : April to June.
(*iii*) Rainy Season : July to October.

The duration of each season, however, varies appreciably in different parts of the country.

Figure 3 shows climatic distribution in India

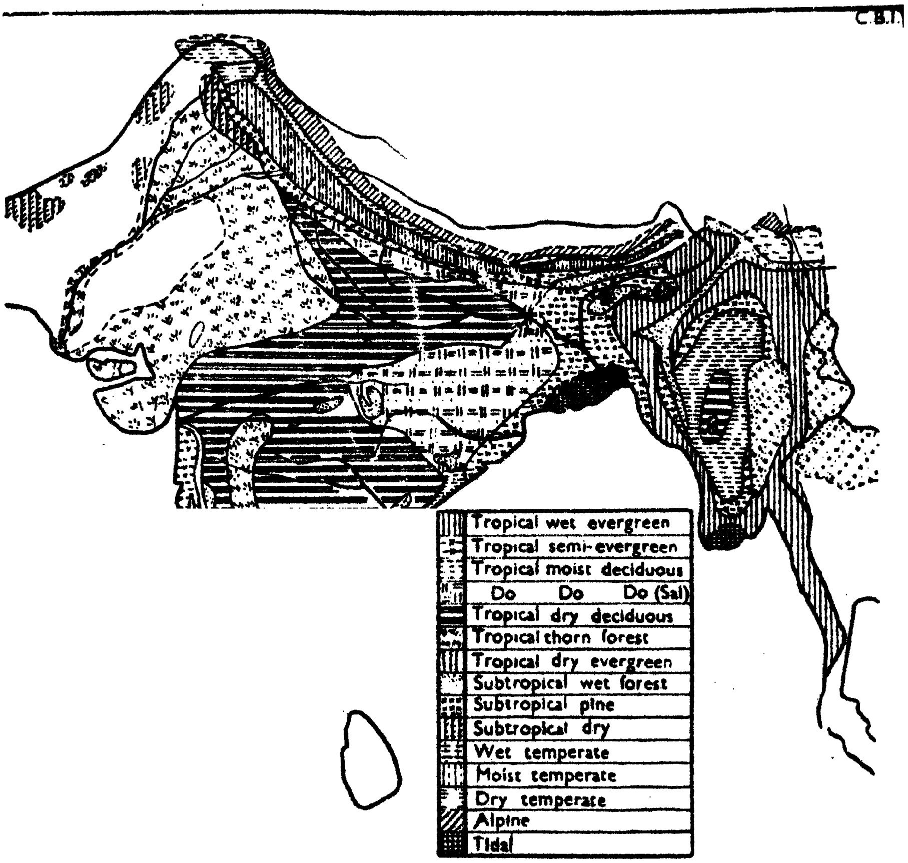

Figure 3 : *Climatic distribution in India*

TEMPERATURE

The temperature of the air at any place depends upon many factors, of which the most important in India are the altitude of the sun, latitude, elevation, distance from the sea and the character of the prevailing winds. The variation of temperature with latitude changes in India with the season. In the winter from November to February, temperature decreases with increase of latitude and hence from south to north, and the isotherms run across India nearly parallel to the lines of latitude. During the summer season, the interior of India is heated above the coastal districts, and the hottest area transferred from the South and Central Deccan to North Western India. The isotherms during this period are hence closed curves about a Central area. During the remainder of the year, the south-west monsoon or rainy season, temperature is permanently the highest in the North-West Rajputana and decreases rapidly for some distance to the east and south. It is almost uniform over the area of frequent rainfall, including about two-thirds of India, over which it varies only slightly throughout the period. Temperature on the whole increases with increase of latitude in India in this season.

In the design of dams, the engineers in India are not concerned so much with the general temperature conditions of the particular regions as with the variation in maximum and minimum temperatures.

Figure 4 shows isotherms of maximum and minimum temperatures in India.

RAINFALL

Rainfall is the primary source of water supply in the rivers. The chief characteristics of the rainfall in India are its unequal distribution over the country, its irregular distribution throughout the season and its liability to failure or serious deficiency. The meteorological conditions in India like those of other countries are largely a result of its geographical position. The great land area of Asia to the north and the enormous sea expanse of the Indian ocean to the south are determining factors in setting its meteorological features. When the Northern Hemisphere is turned away from the sun, Central Asia becomes an area of intense cold. The meteorological conditions of the temperature zone are pushed south-ward and the northern provinces of India get the westerly winds and eastward moving cyclonic storms of temperate region, while, when the Northern Hemisphere is turned towards the sun, southern Asia becomes a super-heated region drawing towards it an immense current of air which carried with it the enormous volume of water vapours which it has picked up over the vast expanse of the Indian Ocean, so that at one season of the year, parts of India are deluged with rain and at another persistent dry weather prevails. The general distribution of the annual rainfall in India is shown in Figure 5.

The normal annual rainfall varies from 460 inches at Chirapunji in the Assam Hills to less than 10 inches in Rajputana. Except in the south-east of the Peninsula where the heaviest precipitation occurs from October to December by far the greatest portion of the rain falls during the south-east monsoon, between June and October. During winter months the normal rainfall is comparatively small, varying from half an inch to two inches, while the hot weather from March to May or June, is practically rainless. Consequently it happens that in one season of the year the greater part of India is deluged with rain and is the scene of the most wonderful and rapid growth of vegetation, in the

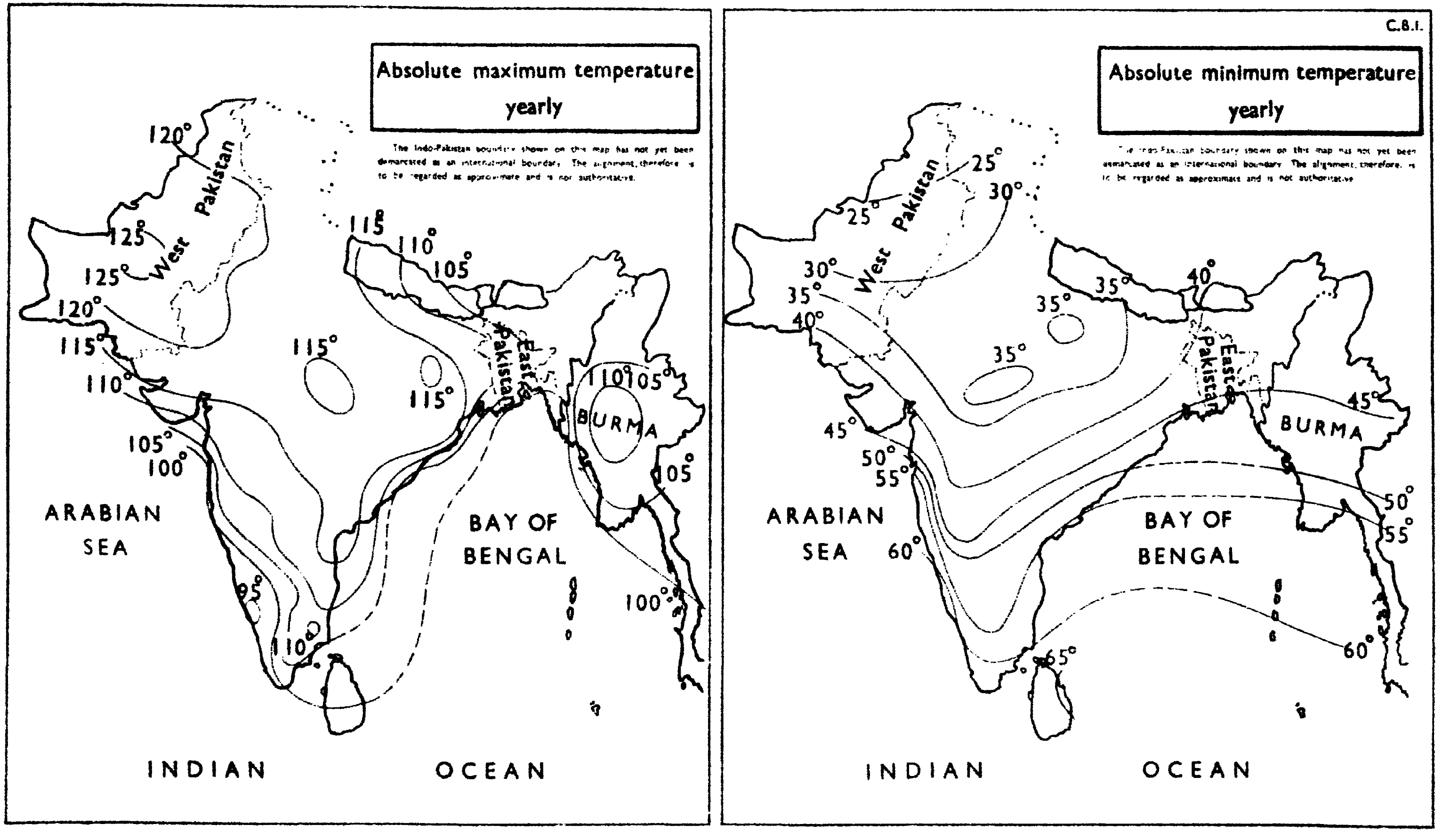
Absolute maximum temperature yearly
The Indo-Pakistan boundary shown on this map has not yet been demarcated as an international boundary. The alignment, therefore, is to be regarded as approximate and is not authoritative.
120°
125°
125°
120°
115°
110°
105°
100°
95°
110°
115°
115°
115°
110°
105°
West Pakistan
East Pakistan
BURMA
110°
105°
105°
100°
ARABIAN SEA
BAY OF BENGAL
INDIAN OCEAN
C.B.I.
Absolute minimum temperature yearly
The Indo-Pakistan boundary shown on this map has not yet been demarcated as an international boundary. The alignment, therefore, is to be regarded as approximate and is not authoritative.
25°
25°
30°
30°
35°
40°
35°
35°
35°
40°
45°
50°
55°
60°
65°
45°
50°
55°
60°
BURMA

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Figure 4:- *Showing yearly isotherms of maximum and minimum temperatures.*

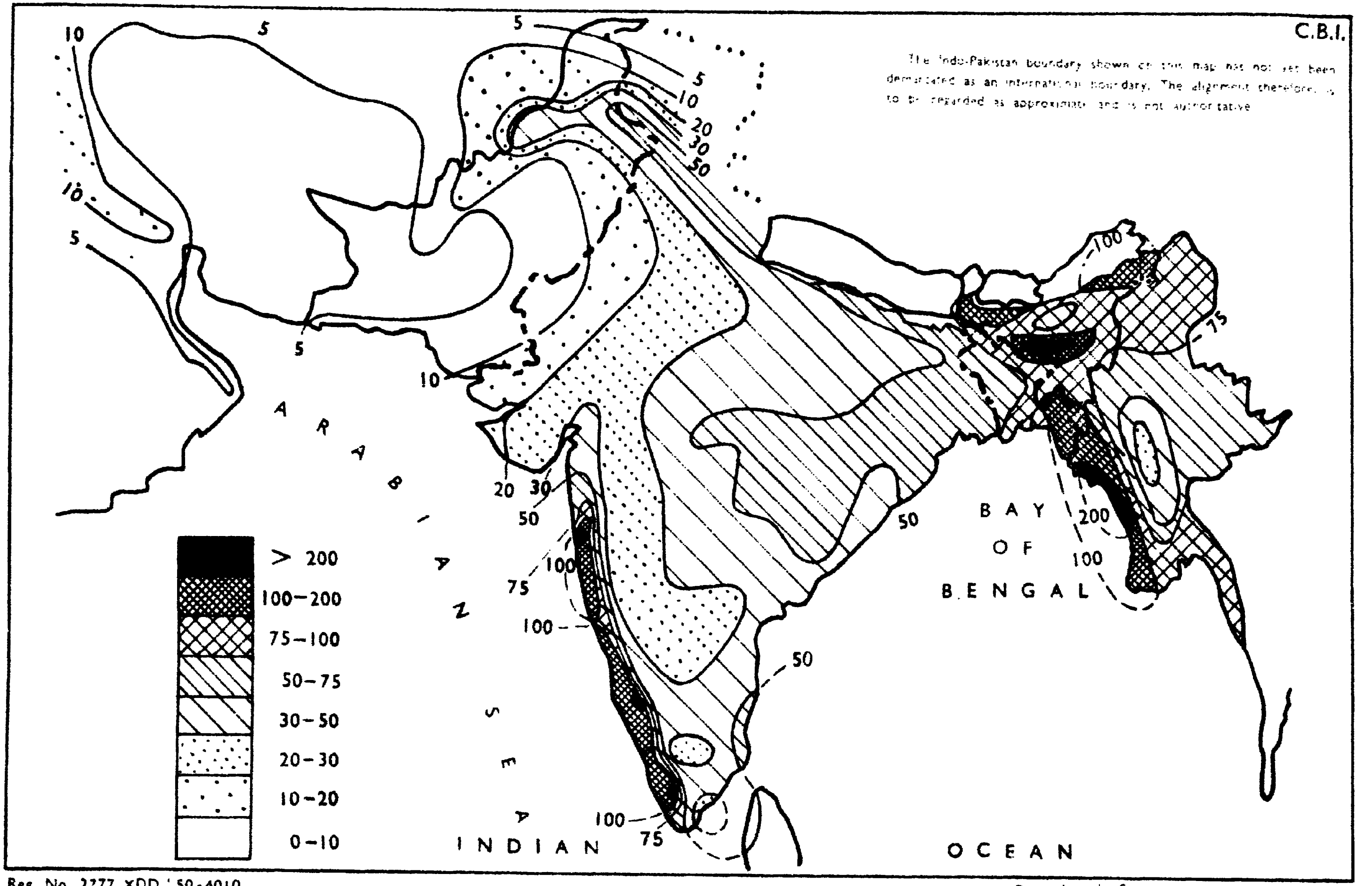
C.B.I.
The Indo-Pakistan boundary shown on this map has not yet been demarcated as an international boundary. The alignment therefore, is to be regarded as approximate and is not authoritative
> 200
100–200
75–100
50–75
30–50
20–30
10–20
0–10
ARABIAN SEA
BAY OF BENGAL
INDIAN OCEAN
5
10
20
30
50
75
100
200

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Figure 5:- *Map Showing Annual Rainfall in India*

other period the same tract becomes a dreary sun-burnt waste. The transition from the latter to the former stage often occurs in a few days. From the agricultural point of view the most unsatisfactory feature of the Indian rainfall is its liability to failure or serious deficiency.

The average annual rainfall over the whole country is about 45 inches and there is but little variation from this average from year to year. But if separate tracts are considered extraordinary variations are found. At many stations annual rainfall of less than half the average is not uncommon, while at some, less than a quarter of the normal has been recorded in a year of extreme drought.

GLACIERS

Glaciers have great economic importance as they constitute the source of important rivers of Northern India. They not only provide the headwaters of such rivers but also continue to feed them by melting snow when the monsoons have ceased to be active. But for these glaciers, the rivers of the Northern India, would have shared the same fate as those of the South. There are twenty-two principal rivers which have a part of their catchments situated in the Himalayas or its ranges and it is the glaciers and snows which in fact support the irrigation systems in the Punjab (East and West) and Uttar Pradesh. The glaciers occur in the zone of the Great Himalaya above 15,000 feet sea-level. No regular measurements have so far been made of these glaciers. The Government of India have recently initiated snow surveys in Sikkim and Nepal under the auspices of the Central Waterpower, Irrigation and Navigation Commission.

RIVERS

The important rivers of India may be divided into two classes *viz.* (1) The rivers of the Peninsula and (2) the rivers of the Extra Peninsular Region.

In the Peninsula the river-systems, as is obvious, are all of great antiquity, and consequently, by the ceaseless soil erosion and disintegration through ages, their channels have approached the last stage of river development, *viz.* the base-levelling of a continent. These rivers have little power of vertical erosion but can only perform lateral erosion *i.e.* they meander from side to side and can only erode their banks. The Peninsular rivers rise in the Western Ghats, almost within the sight of the Arabian Sea. There is some evidence that the Western Ghats formed the water-shed of the Peninsula in former ages and that the land to their west has been faulted down into the sea, probably in early times. This is supported by the fact that the Western Coast has an extraordinary straight line and shelves down rapidly. The westerly courses of the Narbada and the Tapti are, it is thought, mainly determined by fault lines.

The rivers in North of the Peninsula rise from the Aravallis and Central India highlands and join the Ganga system. In this part of India, the Aravallis act as a water shed separating the westerly from the easterly flowing drainages, while the Vindhyas and Satpuras separate the northerly from the southerly flowing drainages.

All the rivers flowing in the easterly direction into the Bay of Bengal have built important deltas at their mouths and there is also a wide belt of the river borne detritus on the east coast. All the rivers in the Peninsula run almost dry in the hot season.

The chief rivers of the Peninsula are the Mahanadi, the Godavari, the Kistna and the Cauvery; and the west-ward flowing, the Narbada and the Tapti; also the Chambal, the Betwa and the Sone draining the northern edge of the Peninsula. On some of these rivers storage and other works have been built but the supply so far used is only an insignificant proportion of the supplies running to waste in the sea. The table I on page 9 gives the mean annual yield of the basins, discharges, supplies utilised *etc.* of some of the important rivers of the Peninsula.

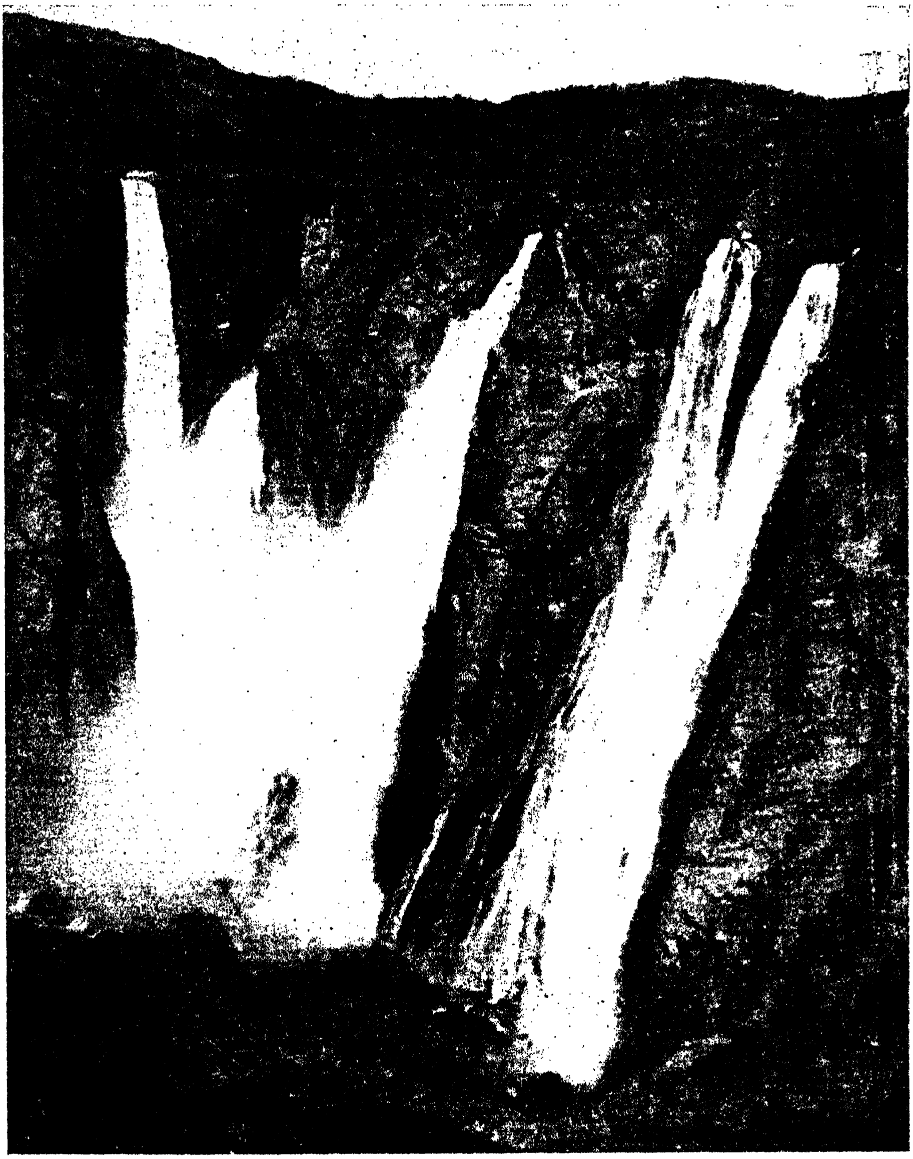
There are several important natural falls on some of these rivers in the Peninsula such as Sivasamudram falls of the Cauvery in Mysore, Gerasoppa Falls of the river Sheravati, Gokak Falls of the river Gokak in Bombay, Dhurandhar Falls of the Narbada at Jubbulpore, Yeuna Falls of the Mahableshwer Hills, Pykara Falls in the Nilgiri Hills. They offer opportunities for developing hydro-electric power. There are also a number of gorges on these rivers which offer facilities for building dams to store water supplies.

The Himalayas proper between the North Western Frontier Province (Pakistan) and North-East corner of Assam, give rise to 22 important rivers which make up the Indus, Ganga and Brahmaputra systems. The main water-shed between Tibet and India is in reality the Trans-Himalayan range and not the Great Himalayan range containing the high peaks. Many of the rivers flow, in the mountains, through deep and steep side gorges. The rivers are torrential in the mountains but have low gradients on reaching the plains. The Table II on page 10 gives the similar informatian as in Table I about these rivers.

The Indus river system comprises the Indus, Jhelum, Chenab, Ravi, Beas and Sutlej. The Ganga system comprises the Ganga, Yamuna, Sarda, Ramganga, Kosi *etc.*, and their several tributaries. The Brahmaputra system includes the Brahmaputra, Tista, the rivers of Bhutan, the Subanseri, Dibang and Lubit.

As in the South, a very small proportion of the available supplies of the rivers in the North have been utilised. On the other hand the flood havoc caused by these rivers take every year a heavy toll of life, property and crops. The table on page 11 gives some of the important statistics relating to the important rivers of the north.

It has been estimated that the total water flowing into Indian rivers is on the average 2·25 million cusecs and at present only 7 percent is utilised, the rest runs to waste to the sea. These rivers also afford a number of sites for hydro-electric generation and it is estimated that the potential water power resources of India are about 40 million kW out of which only 0·5 million kW have been developed so far.



A view of the Gerasoppa Falls (Mysore)

TABLE I

Serial No.	Name of river	Total length of the river in miles	Total catchment area of the river in square miles	Site of observation	Catchment area in square miles above the site of observation	Maximum discharge in cusecs	Average maximum discharge in cusecs	Minimum dry weather flow in cusecs	Average dry weather flow in cusecs	Average total annual yield in acre feet	Percentage at present utilised
1	2	3	4	5	6	7	8	9	10	11	12
1	Mahanadi ..	533	51,000	Hirakud	32,200	942,000	..	900	28,000	50,000,000	*Nil*
				Tikarpara	48,000	1,270,000	..	1,350	41,600	73,370,000	*Nil*
				Naraj	51,000	1,571,000	1,121,667	1,500	42,000	74,000,000	*Nil*
2	Brahmani ..	438	14,000	Janapore	14,000	643,290	..	130	.	22,000,000	..
3	Godavari ..	900	121,500	Dowlaishwaram ..	115,570	2,107,600	938,621	*Nil*	5,100	85,000,000	7 to 8
4	Kistna ..	800	97,050	Bezwada	97,050	1,193,901	522,097	*Nil*	1,880	47,047,500	8
5	Cauvery ..	500	31,000	Post Mettur ..	16,300	186,300	139,720	*Nil*	2,930	12,209,400	57
6	Narbada ..	800	33,750		..	2,000,000 to 3,000,000				100,000,000	*Nil*
7	Tapti ..	450	25,000								
8	Chambal ..	582	35,000		..	..	..	..	..	3,440,000	*Nil*
9	Petwa ..	..	..	Parichha	10,4[illegible]	760,000	327,000	*Nil*	821	7,500,000	
10	Son ..	487	26,000	Dehri	24,000	1,214,450	667,225	614	2,014	28,870,000	8

TABLE II

Serial No.	Name of river	Total length of the river in miles	Total catchment area of the river in square miles	Site of observation	Catchment area in square miles above the site of observation	Maximum discharge in cusecs	Average maximum discharge in cusecs	Minimum dry weather flow in cusecs	Average dry Weather flow in cusecs	Average total annual yield in acre feet	Percentage at present utilised
1	2	3	4	5	6	7	8	9	10	11	12
1	Indus	1,800	311,661	Kalabagh	103,648	917,015	529,420	..	..	..	..
2	Jhelum ..	450	20,482	Mangla .. .	13,352	760,000	..	4,480	8 943	23,000,000	..
3	Chenab ..	..	26,725	Marala	11,110	718,000	207,737	3,578	4,564	23,140,000	..
4	Sutlej ..	900	41,085	Rupar	24,383	490,242	135,877	2,778	3,977	13,500,000	..
5	Beas ..	290	7,122	Mandi	..	..	..	..	..	12,200,000	..
6	Ganga ..	1,557	414,313	Raiwala ..	9,028	800,000	152,849	3,907	11,726	19,900,000	21
				Narora	.	290,000	185,121	1,080	5,472	20,100,000	9
				Hardinge Bridge .	361,000	1,715,000	1,476,455	..	..	..	..
7	Yamuna ..	..	138,180	Tajewala . .	4,386	875,000	93,686	2,099	5,412	7,450,000	47·5
				Okhla .. .	6,800	197,982	67,248	..	1,232	3,820,000	12
8	Ramganga ..	..	.	Head at Rama ..	..	74,000	50,622	100	900	2,190,000	2
9	Sarda ..	..	..	Banbassa . ..	5,788	600,000	247,524	3,802	7,584	16,730,000	20
10	Ken .	..	.	Bariarpur	8,300	591,000	296,600	50	1,098	7,700,000	5
11	Dhasan ..	..	..	Lachura .	5,420	397,000	153,500	..	216	2,140,000	5
12	Kosi ..	.	33,418	Barahkshetra ..	22,388	700,000	..	2,000	..	49,240,000	
13	Damodar .	336	8,500	Rhondia ..	7,800	650,000	275,800	..	1,060	8,110,000	Nil
14	Brahmaputra ..	1,800	227,330	Amingaon ..	..	2,550,000*	..	..	..	..	

*Observed in 1928

EARTHQUAKES

Seismic acceleration affect the stability of a dam by producing horizontal forces in it due to inertia of the dam and the inertia of the water upstream. India can be divided into three regions so far as the occurrence of earthquakes is concerned (see Figure 6).

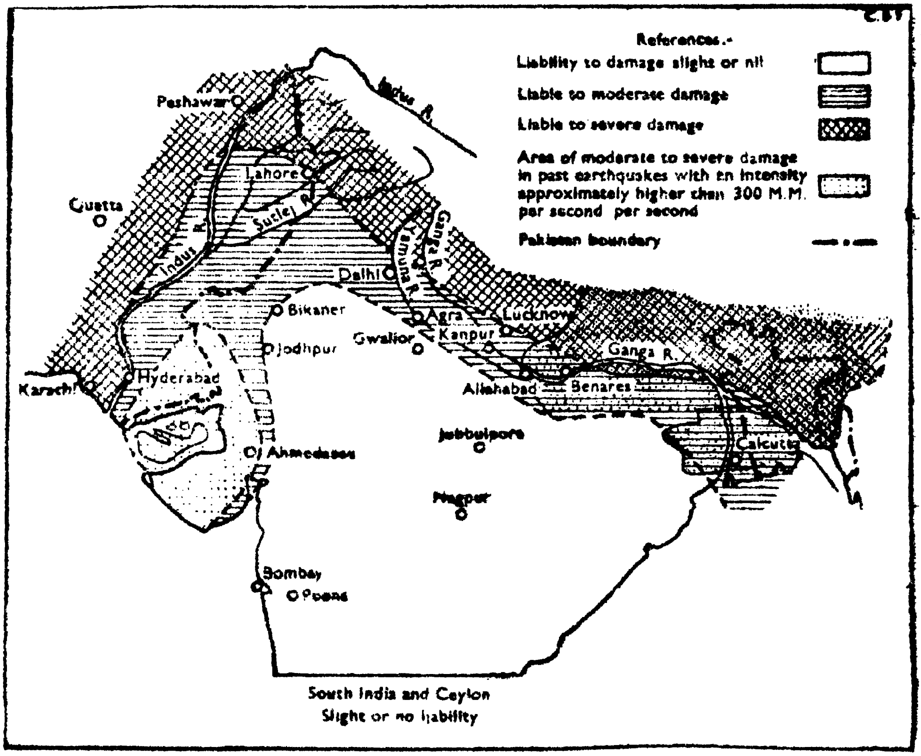


Figure 6 : *Index map of India showing liability to damage by earthquakes*

1. *Himalayan Region.*—This region forms part of a very unstable landmass and the Himalayas have not yet attained their final equilibrium and they are still rising. It has been the scene of some extremely violent earthquakes such as Kangra in 1901 and Kashmir in 1885 which have rocked Northern India.

2. *Indo-Gangetic Plains.*—These plains represent the trough or the foredeep representing the foreland of the Himalayas. These represent the second unit which is affected by earthquakes in a lesser degrees than the Himalaya. Sometimes, however, violent earthquakes like the Bihar earthquakes of 1934 also originate in this region.

3. *Plateau of the Deccan.*—This, as stated earlier, represents a stable landmass and is practically immune from the occurrence of disastrous earthquakes.

These three-divisions, therefore, represent regions with decreasing intensity of earthquakes from north to south.

CHAPTER II

STANDARD FORM

A standard form has been devised for presenting the data of the dams. It includes essential features of all kinds of dams whether masonry, earthen or composite, single purpose or multi-purpose. In individual dams, it is possible that some items of the standard form may not be relevant *e.g.* in an earthen dam items peculiar to masonry structures are not required and *vice versa*. Such items have been omitted where not required but a uniform numbering has been maintained for facility of reference. A complete blank standard form is given below for ready reference of the user of this publication.

Wherever any information is not available, the space has been left blank. Data of a negative character have been clearly indicated as such.

STANDARD FORMS

DAM

I. GENERAL

(1) Height above the lowest river bed
(2) Location
(3) Authority or owner
(4) Purpose-Main and subsidiary
(5) Year of commencement
(6) Year of completion
(7) Capital cost—
  (*a*) Estimated
  (*b*) Actual
(8) Culturable area commanded by the project
(9) Area irrigated
(10) Installed hydro-electric capacity—
  (*a*) Firm
  (*b*) Secondary
(11) Means of access

II. GEOPHYSICAL

(1) Area of catchment
(2) Nature of catchment
(3) Mean annual precipitation—
  (*a*) Rainfall
  (*b*) Snow
(4) Total Average annual yield of the catchment
(5) Climate

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(1) Area of catchment
(2) Nature of catchment
(3) Mean annual precipitation—
  (*a*) Rainfall
  (*b*) Snow
(4) Total Average annual yield of the catchment
(5) Climate

(6) Temperature conditions and variations

(7) Rate of Flow—
  - (a) Maximum
  - (b) Minimum

(8) Detritus charge of the stream

(9) Character (chemical) of the water stored in the reservoir

(10) Geological features—
  - (a) of foundations
  - (b) of catchment area

(11) Earthquake (zone and intensities)

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data—
  - (a) M.W.L.
  - (b) F.R.L.
  - (c) Area at M.W.L.
  - (d) Area at F.R.L.
  - (e) Maximum length
  - (f) Maximum width
  - (g) Length of periphery

(2) Capacity of the reservoir—
  - (a) Gross
  - (b) Live
  - (c) Flood storage
  - (d) Carry-over

(3) Maximum height above the lowest point of foundations

(4) Height above the lowest river bed at dam

(5) Height of the top of the dam above the crest of the spillway or weir

(6) Maximum width at level of foundation

(7) Width at top

(8) Batter of face slopes
  - (a) Upstream
  - (b) Downstream

(9) Length at top of the dam—
  (*a*) Non-overflow—
    (*i*) Main
    (*ii*) Subsidiary
  (*b*) Spillway

(10) Cubic volume of the body of the dam

B. OTHERS

(11) Material of which the dam is constructed

(12) Specific gravity—
  (*a*) Masonry
  (*b*) Concrete
  (*c*) Rockfill
  (*d*) Earthfill

(13) Nature of protection and waterproofing of the upstream and downstream faces

(14) Provision for dealing with seepage and drainage water

(15) Means of securing water tightness of the foundations of the dam

(16) Contraction joints

(17) Principal stresses in the masonry with a note of methods of calculations employed

(18) Maximum pressure on foundations

(19) Uplift pressure, calculated or measured

(20) Measures adopted for preventing or counteracting uplift pressures

(21) Hydraulic gradient for which the embankment is designed

(22) Particular of the berm (if any), width and position

(23) Position and form of the core wall (or other means of securing water tightness)

(24) Batter (if any) of the core wall

(25) Maximum depth below ground surface of core-wall or other means of securing water tightness

(26) Method of keying core-wall or other wall in the under-lying ground

(27) Nature of material forming the core or other wall

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) Land submerged—
  (*a*) Crown waste
  (*b*) Proprietory
(2) Dislocation—
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads—
    (*i*) Highways
    (*ii*) District Roads
    (*iii*) Village Roads
  (*e*) Railway Lines
  (*f*) Temples, Mosques, *etc.*
  (*g*) Graves, *etc.*
  (*h*) Trees, Gardens, Pastures, Houses, Wells, *etc.*
  (*i*) Bridges
(3) Compensation paid under each category of item (2)
(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplusing works

(2) Outlet works

(3) Scouring works

(5) Inspection facilities

(6) Fish-pass

(7) Means for dissipating energy below the spillway

VI. POWER WORKS

1) Hydraulic head

2) Name and address of Licensee with managing agents (if any)

3) Generating units—
   - (a) Type
   - (b) Number
   - (c) Capacity—
     - (i) Firm
     - (ii) Secondary

4) Voltage

5) Number of phases and frequency, A.C. or D.C.

6) Forebay

7) A brief description of tunnel and penstocks

8) Means provided for excluding silt and trash

9) Tail race

10) Maximum length of transmission line

11) Principal towns served

12) Main and subsidiary purpose of the utilisation of electricity

13) Any other matter of interest

VII. NAVIGATION WORKS

(a) Length of river where navigation has been made possible by the construction of the dam

(b) Type of cargo transported

(c) Number of passengers transported annually

(d) Annual income from source at item (b) and (c)

(e) Navigation Lock :
   - (i) Location
   - (ii) Lock chamber, clear size
   - (iii) Lift (i) Maximum
     (ii) Minimum
   - (v) Estimated lockage time

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the dam—
  (*a*) Regulation
  (*b*) Silting of the reservoir—
    (*i*) Total silt deposited
    (*ii*) Rate of silting
    (*iii*) Density of the silt deposited
    (*iv*) Rate of advancement of delta
  (*c*) Actual yield as against estimated
  (*d*) Various measurements and observations—
    (*i*) Evaporation losses
    (*ii*) Sweating below the dam
    (*iii*) Temperature measurements
    (*iv*) Seepage and regeneration
    (*v*) Settlement
  (*e*) Fish culture
  (*f*) Anti-malaria measures
(5) Recreation facilities

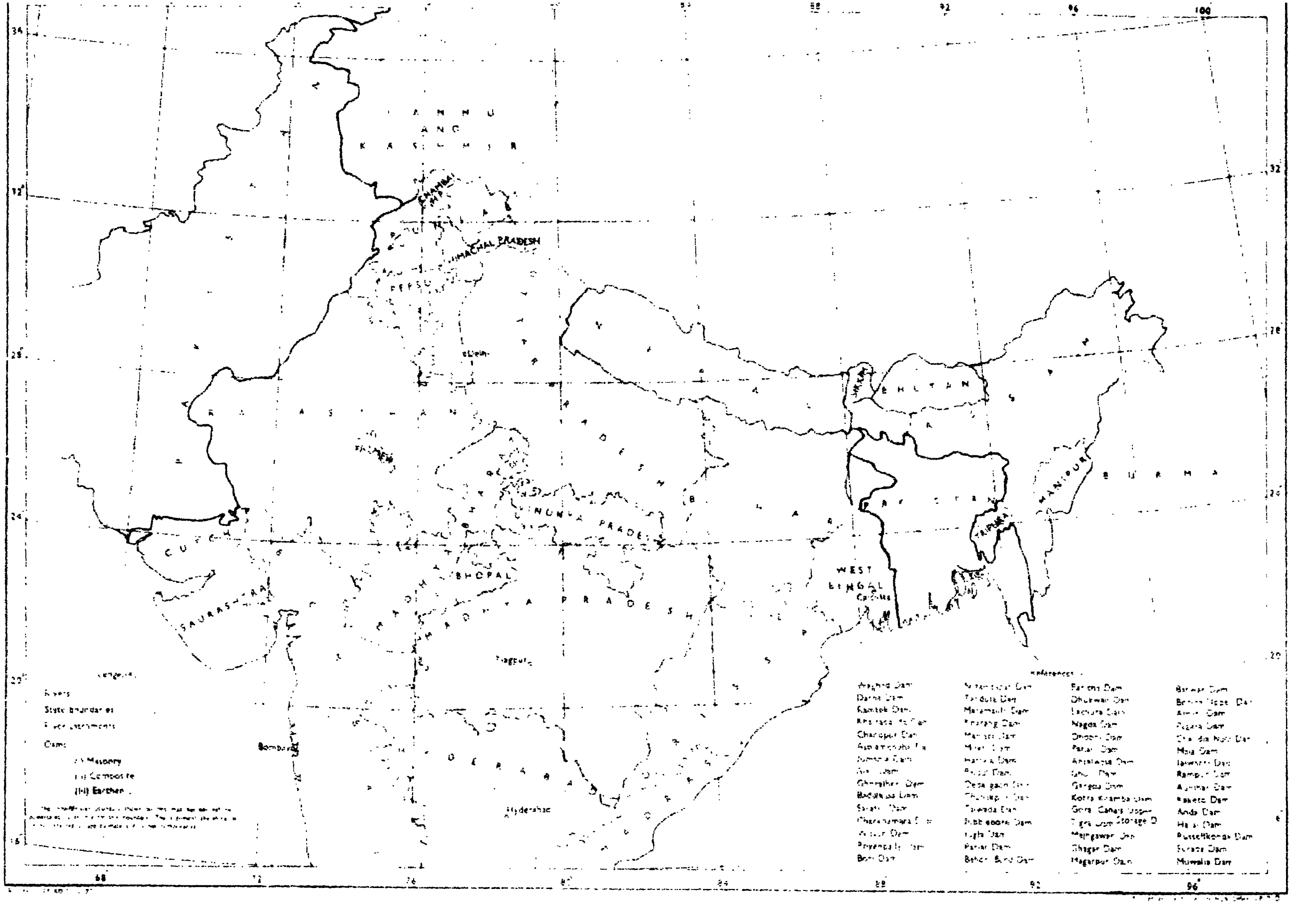
(6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

(3) Bibliography



Part inset Map of India showing location of dams included in volume II

ABBREVIATIONS

In this publication some of the most accepted abbreviations have been used for want of space on drawings *etc.* These are :

F.R.L.	Full Reservoir Level.
M.W.L.	Maximum Water Level.
kW	Kilowatt.
A.C.	Alternating Current.
D.C.	Direct Current.

DAMS IN THIS VOLUME

The dams, the information regarding which is published in this volume include 10 dams of Bombay State, 3 of Hyderabad State, 21 dams of Madhya Pradesh, 2 of Orissa State, 10 of Gwalior State and 15 of Uttar Pradesh. The information has been published basin-wise and not as per territorial boundaries. Table I gives the main features of the dams. Figure 7 shows their location

TABLE

Important statistics of High

Serial No. 1	Name of Dam. 2	Type. 3	Purpose. 4	Year of Completion. 5	Actual Capital Cost Rs. 6	Catchment area in sq. miles. 7	Total useful capacity (acre-feet)*. 8	Height above the lowest river bed feet. 9
	GODAVARI BASIN							
1	Waghad Dam ..	Earthen ..	Irrigation ..	1911	6,83,800	29	11,938	96
2	Darna Dam ..	Masonry ..	Do.	1912	34,27,165	156	178,242	84
3	Ramtek Dam	Earthen	Do. ..	1913	12,62,986	82	93,178	72·8
4	Khairbanda Dam	Do. ..	Do. .	1915	1,98,597	16·52	13,364	59·6
5	Chandpur Dam	Do. ..	Do. ..	1915	2,01,200	28	26,423	62·3
6	Asola Mendha ..	Do.	Do. ..	1918	6,41,211	91·8	65,491	59·3
7	Jumandi Dam ..	Do. ..	Do. ..	1921	2,85,635	11·8	7,438	50·5
8	Alair Dam ..	Masonry .	Do. ..	1922	[illegible]	250	55,280	49
9	Ghorajheri Dam	Earthen ..	Do. ..	1923	1,78,[illegible]	15	[illegible]	65·75
10	Sarathi Dam ..	Do. ..	Do. ..	1923	4,75,778	27·8	[illegible]	58·00
11	Charakhomara Dam	Do. ..	Do. ..	1923	4,27,668	26	[illegible]	[illegible]
12	Badalkasa Dam	Do. ..	Do. ..	1923	1,62,161	23·5	16,001	63·5
13	Wilson Dam ..	Masonry ..	Do. ..	1926	94,11,188	47	270,8[illegible]	270
14	Royenpally Dam	Earthen ..	Do. ..	1926	3,17,531	51	4,560	54·5
15	Bori Dam ..	Do. ..	Do. ..	1927	10,67,262	20·3	8,092	54·7
16	Nizamsagar Dam	Masonry ..	Do. ..	1931	2,18,450	8,376	587,660	115·5
	MAHANADI BASIN							
17	Tandula Dam ..	Earthen ..	Irrigation ..	1921	32,86,600 (works only)	319·4	222,950	82·1
18	Maramsilli Dam ..	Do. ..	Do. ..	1923	31,17,537 (works only)	187	131,267	83·7
19	Kharung Dam ..	Do. ..	Do. ..	1931	12,37,526 (works only)	237	155,900	69·1
20	Maniari Dam	Do. ..	Do. ..	1933	17,76,300 (works only)	310	119,743	95
	TAPTI BASIN							
21	Mukti Dam ..	Earthen ..	Irrigation ..	1873	4,68,621	20·6	7,347	65·1
22	Hortala Dam	Do. ..	Do. ..	1875	73,382	6·8	3,096	51·5
23	Parsul Dam ..	Do. ..	Do. ..	1894	2,05,227	17·33	2,725	62
24	Dedargaon Dam	Do. ..	Do. ..	1897	..	14	3,719 (Gross)	52·92
25	Chankapur Dam	Masonry ..	Do. ..	1911	13,45,349	100	33,609	101
26	Talwada Dam ..	Earthen ..	Do. ..	1915	..	10·5	2,691	54

I

Dams in Volume II

Maximum height of the top of the dam above the lowest point of foundation feet 10	Maximum width at the level of foundation feet 11	Length at top of Dam (feet) 12	Volume of the body of the dam in million C. feet 13	Power Hydraulic head (feet) 14	 Generating unit and type 15	 Installed Capacity in kW 16	Area Irrigated in acres 17	Cost per foot length of dam (Rupees) 18	Cost per acre foot of useful capacity (Rupees) 19
105	600	4,840	4·69	..	..	..	4,581	141	57
92	62	5,360	6·59	..	..	..	60,442	639	19
90·4	412·4	11,496	18·1	..	..	..	14,895	110	14
59·6	279	7,035	8·7	..	..	..	5,702	28	15
90·5	415·4	3,454	3·76	..	..	..	10,891	58	8
85·3	393·6	8,940	20·92	..	..	..	24,506	67	10
72·1	282·25	9,276	13·0	..	..	..	5,878	31	39
29	64·74	2,100	2·84	..	..	..	..	1,530	58
77·25	392	3,910	5·19	..	..	..	4,308	46	6
80·7	370·7	6,543	20·05	..	..	..	8,995	73	37
78·5	390·4	3,833	13·44	..	..	..	6,690	108	23
89·0	354·7	1,700	3·25	..	..	..	6,869	96	10
270	233·8	1,663	12·00	..	..	..	55,934	5,060	33
57·5	300	4,100	..	..	..	..	1,250	77	70
78·6	283·5	6,248	8·2	..	..	..	6,312	171	132
157·5	118	10,350	30·65	..	..	..	275,000	2,114	38
107·1	548·4	14,500	92·24	..	..	..	150,524	234	15
105·7	525·55	8,500	44·44	..	..	..	200,006	367	24
96·24	379·55	7,309	15·06	..	..	..	42,294	169	8
113	547	9,015	38·46	..	..	..	..	197	15
68·25	299	1,900	..	..	..	..	..	247	64
59·5	263·5	1,500	..	..	..	..	420	49	24
..	298	2,770	..	..	..	..	1,783	74	75
..	283·83	1,955	..	..	..	..	..		..
140	91	1,506	..	..	..	..	9,744	893	40
60	278	..	..	..	..	..	..	..	..

TABLE

Important statistics of High

Serial No. 1	Name of Dam 2	Type 3	Purpose 4	Year of Completion 5	Actual Capital Cost Rs. 6	Catchment area in sq. miles 7	Total useful capacity (acre-feet) 8	Height above the lowest river bed (feet) 9
	NARBADA RIVER BASIN							
27	Jabalpore Dam	Masonry ..	Water Supply	1883	2,93,938 (works only)	5·26	5,109	69
28	Jagla Dam ..	Earthen ..	Irrigation	1916	69,360 (works only)	5·0	3,413	57
29	Pariat Dam ..	Earthen ..	Irrigation	1927	11,11,039	42	15,005	74·8
30	Bahori *Bund* Dam	Earthen ..	Irrigation	1929	13,04,700	42	27,972	73
	GANGA RIVER BASIN							
31	Paricha Dam ..	Masonry ..	Irrigation	1885	43,71,251	10,384	67,723	53
32	Dhukwan Dam ..	Do. ..	Do. ..	1909	..	8,240	86,295	46·45
33	Lachura Dam ..	Do. ..	Do. ..	1910	7,02,288	3,420	29,155	45·39
34	Nagda Gojra Dam	Earthen ..	Do. ..	1911	82,869	18	9,607	51
35	Dhobni Dam ..	Do. ..	Do. ..	1911	1,13,843	5	2,752	53
36	Pahari Dam ..	Masonry ..	Do. ..	1913	8,64,578	3,026	64,325	45·71
37	Antalwasa Dam ..	Earthen	Do. ..	1913	1,18,710	12	4,759	52·6
38	Ghori Dam ..	Earthen ..	Irrigation	1914	2,53,256	14	7,436	41·16
39	Gangao Weir Dam	Masonry ..	Do. ..	1915	17,95,536	7,193	48,324	43
40	Kotra Khamba Dam	Earthen	Do. ..	1915	51,621	2·6	2,480	59·4
41	Gorai Canals (upper storage)	Earthen ..	Irrigation	1915	..	29	21,924 (Gross)	69·65
42	Tigra Dam ..	Masonry ..	Irrigation and domestic supply	1917	53,05,978	160	100,756	79·08
43	Majhgawan Dam	Earthen ..	Irrigation	1917	3,68,197	30·2	21,717	55·7
44	Ghagar Dam ..	Masonry ..	Irrigation	1917	42,73,314	110	1,20,809	67
45	Khaptia Dam ..	Earthen ..	Irrigation	1919	1,22,292	4·46	4,821	52·22
46	Magarpur Dam	Do. ..	Do. ..	1920	..	4·75	1,997	34·35
47	Barwai Dam ..	Do. ..	Do. ..	1923	..	65	27,388	62·54
48	Borina Upper Dam	Masonry ..	Irrigation	1923	6,72,824 (works only)	14·40	1,240	69
49	Amahi Dam ..	Earthen ..	Do. ..	1925	2,69,370	20·7	10,207	53
50	Pagara Dam ..	Composite	Do. ..	1927	20,00,000	200	134,550	M-74·0 E89·4

Dams in Volume II—(contd.)

Maximum height of the top of the dam above the lowest point of foundation feet 10	Maximum width at the level of foundation (feet) 11	Length at top of Dam (feet) 12	Volume of the body of the dam in million C. feet 13	Power Hydraulic head (feet) 14	 Generating unit and type 15	 Installed Capacity in kW 16	Area Irrigated in acres 17	Cost per foot length of dam (Rupees) 18	Cost per acre foot of useful capacity (Rupees) 19
74	52·2	1,718	1·21	..	.	..	..	171	57
72·4	261·5	1,040	3·06	..	..	..	[illegible]	68	20
409·6	390	3,875	15·60	..	.	..	6,170	287	75
90	407·5	5,813	6·54	..	..	..	2,240	224	47
84·8	64	3,853	..	..	.	..	180,000	1,134	6·4
50	50	3845·75	..	..	..	..	..	..	..
57	54·5	1778·5	..	..	..	..	.	395	24
51	265·51	900	0·95	..	..	.	..	92	8·6
53	283·5	3,000	7·0	..	..	.	..	38	41
54	50·5	1903·7	..	..	..	..	..	454	13·4
82·6	273·75	5,000	7·42	.	..	..	..	24	25
54·66	240	3,950	15·3	..	..	..	[illegible]	64	34
53	46	2,629	2·75	..	..	..	[illegible]	683	37
59·4	318	2,650	2·86	..	..	..	135	19	21
50·65	341·9	3,875	10·17	..	..	..	..	.	..
82·96	60	..	6·4	..	..	..	..	.	53
63·74	387·44	4,310	13·49	..	..	..	.	56	17
98·26	43	2,283	204·86	..	..	.	70,000	1,478	35
52·22	295·32	1,673	6·77	..	..	..	331	73	25
51·52	181·75	2,486	..	..	..	.	..	.	..
89·9	331·66	3,608	..	..	..	..	..	..	..
74	100	1,041	2·68	..	..	..	421	[illegible]	[illegible]
59	247·5	8,300	13·41	..	..	.	.	32	26
M 77 E 97·4	M 57·5 E470·0	5,900	19·32	..	..	..	..	339	15

TABLE

Important statistics of High

Serial No. 1	Name of Dam 2	Type 3	Purpose 4	Year of Completion 5	Actual Capital Cost Rs. 6	Catch ment area in sq. miles 7	Total useful capacity (acre-feet) 8	Height above the lowest river bed feet 9
51	Chandia Nala Dam	Masonry ..	Irrigation	1927	6,32,447	31	4,675	83
52	Mala Dam ..	Earthen ..	Do. ..	1929	3,17,077 (works only)	63	13,671	66
53	Jaiwanti Dam ..	Do. ..	Do. ..	1929	6,25,840	13·75	5,682	50·7
54	Rampur Dam ..	Composite	Do. ..	1931	6,16,641	102	27,512	M 56 E 71
55	Aunjhar Dam ..	Earthen ..	Do. ..	1931	3,01,364	6·25	3,712	70·6
56	Kekato Dam .	Masonry ..	Do. ..	1933	35,10,773	400	57,324	166·7
57	Aoda Dam ..	Composite	Irrigation & drinking purposes	1934	23,64,173	83	35,658	M54·8 E50·6
58	Harsi Dam ..	Earthen	Irrigation	1937	77,42,903	726	1,55,910	96·2
	MINOR BASINS							
59	Russell Konda Dam	Do. ..	Do. ..	1901		25	34,329 Gross	57·5
60	Surada Dam ..	Do. ..	Do. ..	1902	4,26,200 (Estimated)	200	28,506	43
61	Muwalia Dam ..	Do. ..	Do. ..	1910	3,70,712	30	5,441	58

I

Dams in Volume II—*concld.*

Maximum height of the top of the dam above the lowest point of foundation (feet) 10	Maximum width at the level of foundation (feet) 11	Length at top of Dam (feet) 12	Volume of the body of the dam in million C. feet 13	Power			Area Irrigated in acres 17	Cost per foot length of dam (Rupees) 18	Cost per acre foot of useful capacity (Rupees) 19
				Hydraulic head (feet) 14	Generating unit and type 15	Installed Capacity in kW. 16			
83	43·5	1,081	0·70	..	..	..	1,591	585	136
71·4	321·45	8,900	8·23	..	..	..	..	36	23
50·7	279·20	11,000	19·76	..	..	..	250	57	11
M 65 E 78·5	M 50 E 369	5,250	12·99	..	..	..	..	117	22
70·6	400·6	3,464	12·90	..	..	..	688	87	81
107	96·26	3,435	6·0	..	..	..	..	1,022	61
M 63 E 70	M 50·5 E 289	20,940	20·49	..	..	..	..	113	66
104	530·4	7,000	69·87	..	..	..	..	1,106	50
59	290	4,300	..	..	..	..	..		..
..	237	19,800	..	..	..	..	..	22	1·5
64	287·65	2,098	8·93	..	..	..	2,000	177	68

CHAPTER VI

GODAVARI BASIN

VI. 1. Waghad Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	96 feet
(2) Location	Nasik District, Bombay State, (Walwan river)
(3) Authority or owner	Bombay Government
(4) Purpose-Main and subsidiary	Irrigation
(5) Year of commencement	1881
(6) Year of completion	1911
(7) Capital cost	
(*a*) Estimated	Rs. 2,52,700
(*b*) Actual	Rs. 6,83,800
(8) Culturable area commanded by the project	36,430 acres
(9) Area irrigated	4,581 acres
(11) Means of access	It is accessible from Nasik Peint road by an approach road. The distance from Nasik is 21 miles and nearest railway station is Nasik Road (Great Indian Peninsula Railway).

II. GEOPHYSICAL

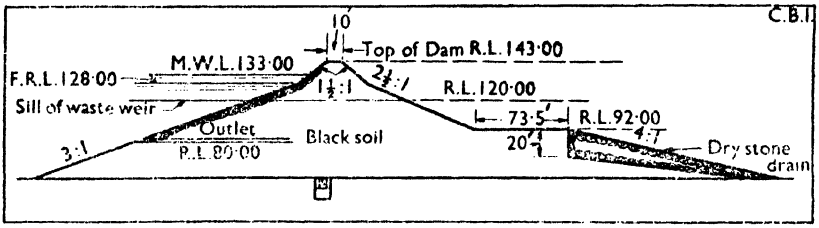
(1) Area of catchment	29 square miles
(2) Nature of catchment	Hilly rocky and moderately sloping. Fan-shaped.
(3) Mean annual precipitation	
(*a*) Rainfall	51·04 inches
(4) Total average annual yield of the catchment	40,880 acre feet
(5) Climate	Hot from April to end of May. Heaviest rainfall generally occurs in August.

(6) Temperature conditions and variations	Maximum temperature 107° F Minimum temperature 64°F } in Summer Maximum temperature 86°F. Minimum temperature 50°F. } in Winter
(7) Rate of flow—	
(a) Maximum	8,382 cusecs
(b) Minimum	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	Sweet-Suitable for irrigation
(10) Geological features	
(a) of foundations	Hard trap rock for key trench and under embankments presumably hard *moorum*
(b) of catchment area	Hilly, rocky and moderately sloping

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(a) M. W. L.	R. L. 133·00 from the arbitrary datum
(b) F. R. L.	R. L. 128·00 from the arbitrary datum
(c) Area at M. W. L.	1·22 square miles
(d) Area at F. R. L.	
(e) Maximum length	
(f) Maximum width	
(g) Length of periphery	
(2) Capacity of the reservoir	
(a) Gross	13,912 acre feet
(b) Live	11,938 acre feet
(c) Flood storage	
(d) Carry-over	



Cross Section of Waghad Dam (not at maximum depth)

(3) Maximum height above the lowest point of foundations	105 feet
(4) Height above the lowest river bed at dam	96 feet
(5) Height of the top of the dam above the crest of the spillway or weir	23 feet from the sill of the waste weir
(6) Maximum width at level of foundations	600 feet
(7) Width at top	10 feet
(8) Slopes	As per cross section
(*a*) Upstream	
(*b*) Downstream	
(9) Length at top of the dam	4,840
(*a*) Non-overflow	
(*i*) Main	4,610 feet
(*ii*) Subsidiary	280 feet
(*b*) Spillway or waste weir	200 feet. Also additional waste weir of 200 feet.
(10) Cubic volume of the body of the dam	4,690,100 cubic feet

B. OTHER

(11) Material of which the dam is constructed	*Moorum* and red earth.
(12) Specific gravity	
(13) Nature of protection and water-proofing of the upstream and down-stream faces	Rubble pitching or upstream side 4 feet above High Flood Level *i.e.*, R. L. 137·00.
(14) Provision for dealing with seepage and drainage water	

(15) Means of securing water tightness of the foundation of the dam	There is no regular core wall. Black soil mixed with *moorum* is used for hearting. There is a puddle trench 10 feet to 16 feet wide at bottom in the midst of which there is a concrete trench 7 feet to 10 feet wide.
(21) Hydraulic gradient for which the embankment is designed.	
(22) Particular of the berm (if any), width and position	There is a berm, 73·5 feet wide in the centre of the embankment downstream
(23) Position and form of the core wall (or other means of securing water tightness)	There is no regular core wall. Black soil mixed with *moorum* is used for hearting. There is a puddle trench 10 feet to 16 feet wide at the bottom in the midst of which there is a concrete trench 7 feet to 10 feet wide.
(24) Batter (if any) of the core wall	
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	
(26) Method of keying core-wall or other wall in the underlying ground	
(27) Nature of material forming the core or other wall	

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged* :

(*a*) Crown waste	7·81 acres
(*b*) Proprietory	

(2) *Dislocation* :

- (*a*) Villages
- (*b*) Families
- (*c*) Population
- (*d*) Roads :
  - (*i*) Highways
  - (*ii*) District Roads
  - (*iii*) Village Roads
- (*e*) Railway Lines
- (*f*) Temples, mosques, *etc.*
- (*g*) Graves, etc.
- (*h*) Trees, gardens, pastures, Houses, Wells, *etc.*
- (*i*) Bridges

(3) Compensation paid under each category of item (2).

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplusing works	Masonry waste weir of 12 automatic gates 10 feet by 8 feet each. 11 gates are controlled by one counter weight and 12th gate is controlled by a separate one.
(2) Outlet works	There are three sluice valves fixed to to 18 inches cast iron pipes for outlet.
(3) Scouring works	
(4) Inspection facilities	There is a draw off tunnel and a valve tower. Steps have been provided to go down into the valve tower for their inspection.
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurrences and accidents	During its construction, a hair crack was observed on the rear slope near the sluice outlet on the 27 April 1884; this crack extended during the day and by the night the rear slope slipped off a length of 250 feet. The toe of the dam moved on an average 50 feet downstream. The following measures were undertaken to save the dam : (1) Second safety waste weir was cut in the existing natural saddle. (2) A temporary earthen dam was made on the top of the gorge embankment. (3) The rear slope of the dam which slipped was dressed and a berm 33 feet wide and 22 feet in height was constructed on its toe.

(4) Dry stone wall was founded 7 feet deep in the river bed and with superstructure of 6 feet high, on the downstream end of the berm.

These works were completed on 14-6-1884. After the rains of 1884, it was decided to raise the top of the whole dam to R. L. 138·00 with additional slope in the rear at the gorge portion. Slope to provide for the safe escape of flood waters, the cut in the waste weir which was excavated 50 feet wide down to R. L. 116·00 in 1883 was made 100 feet wide down to R. L. 114·00. When the new work at the gorge portion was raised to R. L. 108·00, a crack was seen at the junction of the old and new earth work. Smaller cracks opened out in the berm, and the rear slope generally became more or less distorted. In order to prevent further slipping the following measures were adopted :—

(1) A dry stone wall 12 feet deep was built in the berm at its junction with the dam and the berm was raised from 22 to 32 feet height with earth and *moorum*.

(2) The safety cut embankment was raised to R. L. 135·00 only and a portion of it 100 feet in length was finished at R. L. 133·00 with a lighter section, so as to be easily cut open, should the main dam be again in danger.

(3) The 100 feet cut of the safety waste weir was lowered to R. L. 112·00. This 100 feet cut was again further lowered to R. L. 110·00 in 1886-87 in order to diminish the tank flood height.

This dam again slipped on 24th April 1919, which was in the form of a subsidence on the upstream toe and this subsidence ranged from 16 feet to 25 feet in depth and from 250 feet to 300 feet in length. Immediate steps were taken and a dry rubble toe wall was built to form a footing for the new embankment, which was done with a slope of 3 to 1 and with two berms of 15 feet for great strength. No good soil was available and an admixture of black soil and *moorum*, was used. This new bank again slipped 6 feet downwards on the 6th June 1919. This slip was exactly at the old place of slipping, and this was repaired with a slope of 3 to 1 without berms.

(4) Operation of the dam

- (*a*) Regulation
- (*b*) Silting of the reservoir
    - (*i*) Total Silt deposited
    - (*ii*) Rate of silting
    - (*iii*) Density of the silt deposited
    - (*iv*) Rate of advancement of delta
- (*c*) Actual yield as against estimated
- (*d*) Various measurements and observations
    - (*i*) Evaporation losses
    - (*ii*) Sweating below the dam
    - (*iii*) Temperature measurements
    - (*iv*) Seepage and regeneration
- (*e*) Fish Culture
- (*f*) Anti malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

(3) Bibliography

VI. 2. Darna Dam

(Masonry)

I. GENERAL

(1) Height above the lowest river bed	84 feet
(2) Location	Nasik District, Bombay Presidency (Darna River)
(3) Authority or owner	Government of Bombay
(4) Purpose main and subsidiary	Irrigation
(5) Year of commencement	1907
(6) Year of completion	1912
(7) Capital cost	
(*a*) Estimated	(*a*) Rs. 29,35,631
(*b*) Actual	(*b*) Rs. 34,27,465
(8) Culturable area commanded by the project	219,290 acres out of commanded area 232,390 acres
(9) Area irrigated	60,442 acres
(11) Means of access	The nearest railway station to this dam is Aswali on the main line of Great Indian Peninsula Railway about 101 miles from Bombay. The dam is three miles from this railway station and 21 miles from Nasik city, both connected by metalled roads.

II. GEOPHYSICAL

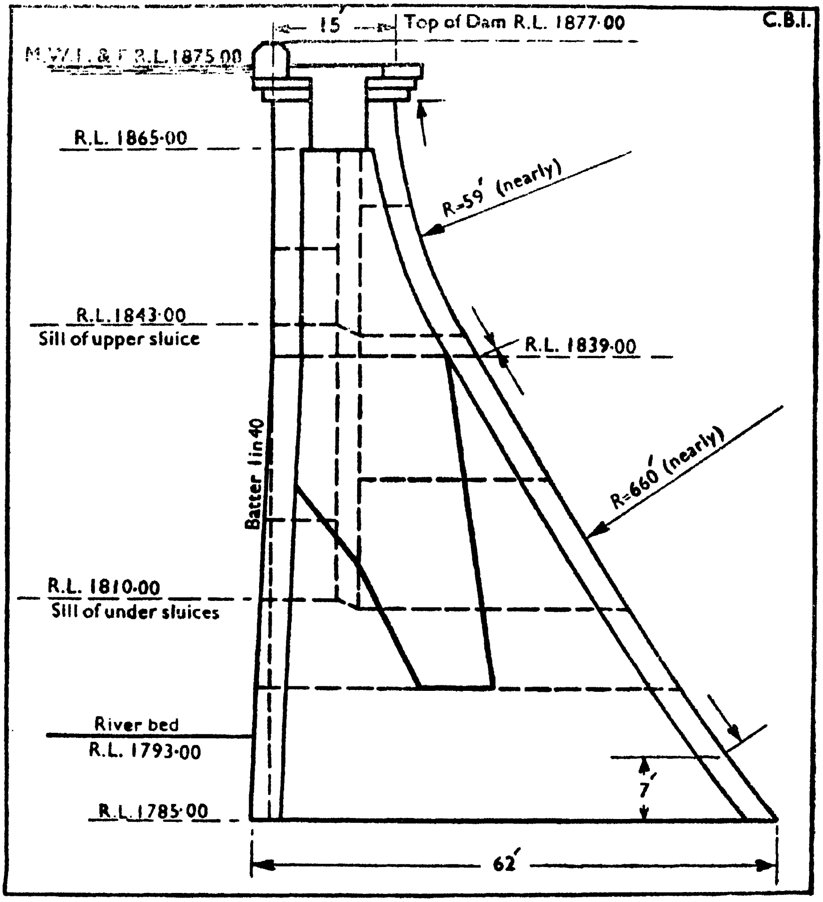
(1) Area of catchment (2) Nature of catchment	156 square miles out of which 90 square miles is typical ghat section producting a very reliable supply.
(3) Mean annual precipitation	
(*a*) Rainfall	(*a*) 125 inches
(4) Total average annual yield of the catchment	573,050 acre feet

(5) Climate	Hot from April to end of May, Heaviest rainfall occurs in August
(6) Temperature conditions and variations	Maximum 64°F to 107°F Minimum 50°F to 86°F
(7) Rate of Flow	
(*a*) Maximum	(*a*) 76,842 cusecs
(*b*) Minimum	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	Sweet, suitable for irrigation
(10) Geological features	
(*a*) of foundations	(*a*) Trap rock
(*b*) of catchment area	(*b*) Steep rocky, hill sides, ***moorum*** slopes ; rice fields with a fair proportion of black soil
(11) Earthquake (Zone and intensities)	Not experienced beyond mild tremors at long intervals

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M.W.L.	(*a*) R. L. 1875·00
(*b*) F. R. L.	(*b*) R. L. 1875·00
(*c*) Area at M. W. L.	(*c*) 13 square miles
(*d*) Area at F. R. L.	(*d*) 13 square miles
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	(*a*) 202,456 acre feet
(*b*) Live	(*b*) 178,212 acre feet
(*c*) Flood storage	(*c*) 69,319 acre feet
(*d*) Carry over	(*d*) 5,739 acre feet
(3) Maximum height above the lowest point of foundations	92 feet
(4) Height above the lowest river bed at dam	84 feet
(5) Height of the top of the dam above the crest of the spillway or weir	10 feet
(6) Maximum width at level of foundations	62 feet



Cross Section of Darna Dam

(7) Width at top	15·0 feet increasing to 17·5 feet by carbelling
(8) Slopes	
(a) Upstream	(a) 1 in 40
(b) Downstream	(b) Arcs of radii 59 feet and 660 feet

(9) Length at top of the dam	5,360 feet
(a) Non-overflow	(a)
(i) Main	(i) 4,480 feet
(b) Spillway	(b) 880 feet
(10) Cubic volume of the body of the dam	6,590,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Uncoursed rubble masonry in lime, faced with uncoursed rubble of hard durable " *Kar* " stones. The higher portion of the dam contains concrete hearting mortar, mixture of river sand and of hydraulic lime in the ratio of 3 to 1 respectively.
(12) Specific gravity	
(a) Masonry	(a) 2·56
(13) Nature of protection and water-proofing of the upstream and down-stream faces	Dam is made up of strong uniform rubble masonry, which is water tight
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundation of the dam	Dam is made up of strong uniform rubble masonry, which is water tight
(16) Construction joints	
(17) Principal stresses in the masonry with a note of methods of calculations employed	
(18) Maximum pressure on foundations	
(19) Uplift pressure, calculated or measured	
(20) Measures adopted for preventing or counteracting uplift pressures	

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged* :	
(a) Crown waste	8,060 acres
(b) Proprietory	
(2) *Dislocation* :	
(a) Villages	
(b) Families	

(*c*) Population	
(*d*) Roads :	
(*i*) Highways	Raising Bombay Agra Road at the cost of Rs. 25,083/-.
(*ii*) District Roads	Roads leading from (1) Ghoti to Bazi, (2) Ghoti to Sinnar were diverted at a cost of Rs. 53,000.
(*iii*) Village Roads	
(*e*) Railway Lines	Diversion of G. I. P. at total cost of Rs. 1,31,461.
(*f*) Temples, mosques, *etc.*	
(*g*) Graves, *etc.*	
(*h*) Trees, gardens, pastures, houses, wells, *etc.*	
(*i*) Bridges	For crossing the river Davana at GHOTI Railway Station Road was diverted for Rs. 21,485.
(3) Compensation paid under each category of item (2).	
(4) Method of compensating for land of dispossessed landholders	Cash.

V. AUXILIARY WORKS

(1) Surplussing works	50 automatic gates each 10 feet by 10 feet 3 inches having its own concrete counter weight. Discharging capacity 71,250 cusecs.
(2) Outlet works	Two upper sluices at R. L. 1843 and two lower sluices at R.L. 1810 each 10 feet by 6 feet high equipped with Patent Stoney type gates.
(3) Scouring works	Six under sluices on right bank each 10 feet by 6 feet high equipped with Patent Stoney type gates with sill at R. L. 1810.
(4) Inspection facilities	
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	The natural resources of the locality provided all the material for construction. No cement was used as the lime mortar proved very hydraulic. The proportion was 3 of sand to 2 of slaked lime and percentage was 49 to masonry.
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurrences and accidents	Early in the year 1914 it was found that one of the under-sluice gates would not properly close. Some of the ashlar stones were dislodged at one end of the rail under the gate, and the former came in the way of the run of the gate. The tank was then emptied in the year 1915 at a suitable time and the gate repaired. To meet such cases a storage capacity at the pick-up weir lower dam was provided for.
(4) Operation of the dam	
(*a*) Regulation	Regulators are equipped with stoney patent gates.
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	Negligible
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	91% of precipitation and the tank is filled every year since year of construction.
(*d*) Various measurements and observations.	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	

(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	The waste weir of Darna Dam comprises 50 automatic gates, each gate is balanced by a counter-weight placed in a chamber or well situated in the dam. The working of the gates has not proved satisfactory according to the design. They do not work automatically unless assistance from a crane is resorted to ; the trouble has been experienced for many years and the gates have never worked automatically in their real sense. The trouble lies in the fact, that the gates bear directly on the channel iron guides, it increases more friction than can be counter-acted by the weight of gate. Another possible trouble is that the rolling wheels of the gates are not in their true central position. As a remedy to these troubles, following measures have been adopted :— (*i*) The diameter of the rolling wheels has been increased by ½ inch in the case of two gates so that they bear fully on the wheels. (*ii*) To check side-play, a roller guide with diameter just smaller than the width of the channel iron is added.

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	Survey for the site of the dam for Godavari canals was started in the year 1902 by Mr. H. F. Beale M. I. C. E., Superintending Engineer on special duty and four sites on the rivers Kadwa and two on Lwanda were investigated but were dropped for unfavourable foundations. Finally this site on the Darma below junction of the Aundh river was selected as this was most favourable on account of good foundations, good bed fall of river and storage. This site is three miles from Asavati Railway Station on G. I. P. Railway and 20 miles from Nasik by road.
(2) Personnel	(*i*) Mr. H. F. Beale, Superintending Engineer. (*ii*) Mr. C. J. Hansoti, Executive Engineer. (*iii*) Mr. H. O. B. Shoubridge, M. I. C. E., Executive Engineer. (*iv*) Mr. S. C. Mould, B. A. Assistant Engineer. (*v*) Rao Bahadur N. V. Barve Sub-Engineer. (*vi*) Mr. V. N. Godbole, L. C. E., Supervisor.
(3) Bibliography	Histories of Godavari Canal headworks (typed note).

VI. 3. Ramtek Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	72·8 feet
(2) Location	Nagpur District, Madhya Pradesh (Sur *Nala*)
(3) Authority or owner	Madhya Pradesh Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1906
(6) Year of completion	1913
(7) Capital cost	
(*a*) Estimated	
(*b*) Actual	Rs. 12,62,986 (works only)
(8) Culturable area commanded by the project	92,493 acres
(9) Area irrigated	14,895 acres
(11) Means of access	It is accessible from Nagpur railway Station by rail as well as by Public Works Department Road. The nearest railway station to the dam site is Ramtek.

II. GEOPHYSICAL

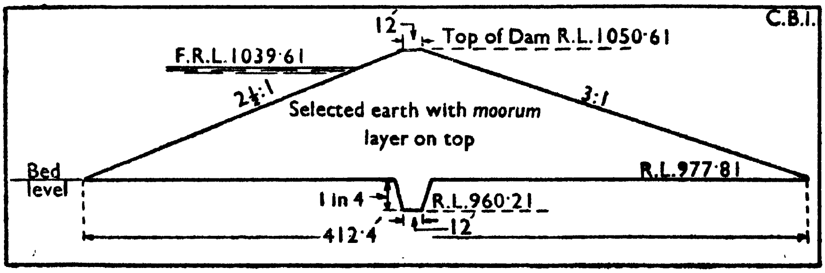
(1) Area of catchment	82 square miles
(2) Nature of catchment	Metamorphic and Crystaline rocks occur. Slopes are moderately steep.
(3) Mean annual precipitation	
(*a*) Rainfall	44·67 inches
(4) Total average annual yield of the catchment	79,660 acre feet
(5) Climate	Temperate.
(6) Temperature conditions and variations	Maximum temperature 115° F Minimum temperature 50°F

(7) Rate of Flow	
(*a*) Maximum	Not recorded, waste weir has never flooded.
(*b*) Minimum	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	Clear for 8 months, and silt laden for 4 months.
(10) Geological features	
(*a*) of foundations	
(*b*) of catchment areas	Earth mixed with boulders over uneven rock full of cracks.

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M. W. L.	
(*b*) F. R. L.	R. L. 1039·61.
(*c*) Area at M. W. L.	
(*d*) Area at F. R. L.	8·2 square miles
(*e*) Maximum length	
(*f*) Maximum width.	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	95,000 acre feet
(*b*) Live	93,178 acre feet
(*c*) Flood storage	
(*d*) Carry-over	



Cross Section of Ramtek Dam

(3) Maximum height above the lowest point of foundations	90·4 feet
(4) Height above the lowest river bed at dam	72·8 feet

(5) Height of the top of the dam above the crest of the spillway or weir	10 feet flank dam and 11 feet main dam	
(6) Maximum width at level of foundation.	412·4 feet	
(7) Width at top	12·0 feet	
(8) Slopes		
(*a*) Upstream	$2\frac{1}{2}$: 1	
(*b*) Downstream	3 : 1	
(9) Length at top of the dam		
(*a*) Non-overflow	Main 710·0 feet	Total 11,310 feet
(*i*) Main	Flank 10,600 feet	
(*b*) Spillway	186·0 feet	
(10) Cubic volume of the body of the dam	12,100,000 cubic feet	

B. OTHERS

(11) Material of which the dam is constructed	Selected earth with *moorum* layer on top
(12) Specific gravity	
(*d*) Earthfill	
(13) Nature of protection and water-proofing of the upstream and downstream faces	Dry stone pitching one foot thick on the upstream side only
(14) Provision for dealing with seepage and drainage water	Seepage drains
(15) Means of securing water tightness of the foundations of the dam	By means of puddle core-wall
(21) Hydraulic gradient for which the embankment is designed	
(22) Particular of the berm (if any), width and position	
(23) Position and form of the core wall (or other means of securing water tightness)	As per Cross Section
(24) Batter (if any) of the core wall	1 in 4
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	17·6 feet
(26) Method of keying corewall or other wall in the underlying ground	Puddle trench corewall
(27) Nature of material forming the core or other wall	Puddle

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged* :
  - (*a*) Crown waste
  - (*b*) Proprietory

(2) *Dislocation* :
  - (*a*) Villages
  - (*b*) Families
  - (*c*) Population
  - (*d*) Roads :
    - (*i*) Highways
    - (*ii*) District Roads
    - (*iii*) Village Roads
  - (*e*) Railway Lines
  - (*f*) Temples, mosques, *etc.*
  - (*g*) Graves, *etc.*
  - (*h*) Trees, gardens, pastures, houses, wells, *etc.*
  - (*i*) Bridges.

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Length of crest wall of first fall 186 feet. Length of crest wall of second fall—186 feet. Length of crest wall of third fall—170 feet. Discharging capacity 18,175 cusecs.
(2) Outlet works	Stoney pattern sluice gate with a capacity to discharge 333·3 cusecs
(3) Scouring works	
(4) Inspection facilities	Sluice tower and tunnel under embankment, accessible for inspection.
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the dam
(*a*) Regulation
(*b*) Silting of the reservoir
(*i*) Total silt deposited
(*ii*) Rate of silting
(*iii*) Density of the silt deposited
(*iv*) Rate of advancement of delta
(*c*) Actual yield as against estimated
(*d*) Various measurements and observations
(*i*) Evaporation losses
(*ii*) Sweating below the dam
(*iii*) Temperature measurements
(*iv*) Seepage and regeneration
(*e*) Fish culture
(*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical
(2) Personnel
(3) Bibliography

VI. 4. Khairbanda Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed.	59·6 feet
(2) Location	Bhandara District, Madhya Pradesh local stream (Godavari Basin)
(3) Authority or owner	Madhya Pradesh Government
(4) Purpose-Main and subsidiary	Irrigation
(5) Year of commencement	1902
(6) Year of completion	1915
(7) Capital cost	
(a) Estimated	
(b) Actual	Rs. 196,597
(8) Culturable area commanded by the project.	17,522 acres
(9) Area irrigated	5,702 acres
(11) Means of access	It is situated three miles North of Gangajheri railway station on the main line of the Bengal-Nagpur Railway

II. GEOPHYSICAL

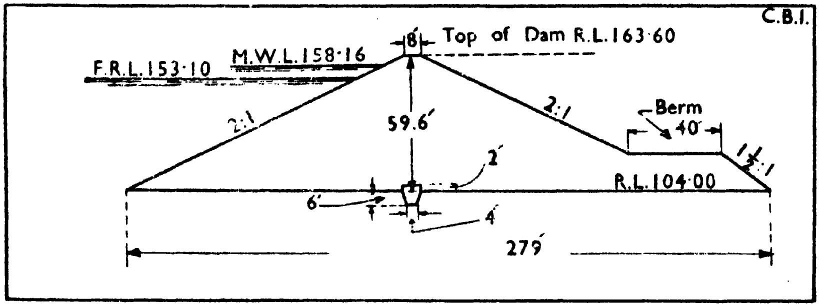
(1) Area of catchment	16·52 square miles
(2) Nature of catchment	Hilly catchment, partly covered with jungle and partly open.
(3) Mean annual precipitation	
(a) Rainfall	47·17 inches
(4) Total average annual yield of the catchment	17,677 acre feet
(5) Climate	Tropical
(6) Temperature conditions and variations	Maximum temperature 118°F. with variation of 25°F max. temp.

(7) Rate of Flow	
(a) Maximum	
(b) Minimum	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	It is clear for eight months and silt laden for four months
(10) Geological features	
(a) of foundations	Dhariwal formation
(b) of catchment area	Hilly and Jungle

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(a) M. W. L.	158·16.
(b) F. R. L.	153·10.
(c) Area at M. W. L.	
(d) Area at F. R. L.	1·56 square miles
(e) Maximum length	
(f) Maximum width	
(g) Length of periphery	
(2) Capacity of the reservoir	
(a) Gross	14,073 acre feet
(b) Live	13,361 acre feet
(c) Flood storage	
(d) Carry-over	



Cross Section of Khairbanda Dam

(3) Maximum height above the lowest point of foundations	Main 59·6 feet, north side 27·5 feet and on south side 24·3 feet.
(4) Height above the lowest river bed at dam	59·6 feet.

(5) Height of the top of the dam above the crest of the spillway or weir	10·5 feet
(6) Maximum width at level of foundations	279 feet
(7) Width at top	8 feet
(8) Slopes	
(*a*) Upstream	2 : 1.
(*b*) Downstream	2 : 1 and 1½ : 1 (berm portion).
(9) Length at top of the dam	8,035 feet
(*a*) Non-overflow	
(*i*) Main	6,735 feet
(*ii*) Subsidiary	
(*b*) Spillway	300 feet (150 feet on each side).
(10) Cubic volume of the body of the dam.	8,700,000 cubic feet.

B. OTHERS

(11) Material of which the dam is constructed.	
(12) Specific gravity	
(*a*) Earthfill	
(13) Nature of protection and water proofing of the upstream and downstream faces	Inner slopes have been pitched throughout with 12 inches stone laid on 6 inches of *moorum*.
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundations of the dam	By means of puddle core-wall.
(21) Hydraulic gradient for which the embankment is designed.	
(22) Particular of the berm (if any), width and position.	It varies according to the height of dam
(23) Position and form of the core wall (or other means of securing water tightness).	
(24) Batter (If any) of the core wall	1 in 4
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	6 feet
(26) Method of keying core-wall of other wall in the underlying ground	Trench core-wall
(27) Nature of material forming the core or other wall	Puddle

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory

(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads
    (*i*) Highways
    (*ii*) District Roads
    (*iii*) Village Roads
  (*e*) Railway lines
  (*f*) Temples, mosques, *etc.*
  (*g*) Graves, *etc.*
  (*h*) Trees, gardens, pastures, houses, wells, *etc.*
  (*i*) Bridges.

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Two drowned waste weirs 150 feet each
(2) Outlet works	Sluice with iron gates
(3) Scouring works	
(4) Inspection facilities	Sluice tower and tunnel under embankment, accessible for inspection
(5) Fish pass	
(6) Means for dissipating energy below the spillway	Four falls have been provided in spillway channel to prevent scour down stream of the weir

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

From the 3 years record of the tank *viz.* 1909-10, 1912-13 and 1913-14, rainfall was considerably under normal. In both the first and second of these years the supply exceeded the demand but in the last year the tank practically failed to supply the designed *kharif* area. Great difficulty was experienced in passing water through the left bank channel system owing to the occurrence of slips in the slopes of a deep cutting, through which the channel runs and the assessment on considerable areas of *kharif* had to be remitted more on this account than on account of actual shortage

(4) Operation of the dam
- (*a*) Regulation
- (*b*) Silting of the reservoir
  - (*i*) Total silt deposited
  - (*ii*) Rate of silting
  - (*iii*) Density of the silt deposited
  - (*iv*) Rate of advancement of delta
- (*c*) Actual yield as against estimated
- (*d*) Various measurements and observations
  - (*i*) Evaporation losses
  - (*ii*) Sweating below the dam
  - (*iii*) Temperature measurements
  - (*iv*) Seepage and regeneration
- (*e*) Fish culture
- (*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) *Historical*

This is one of the projects investigated by Mr. G. S. Morley, Executive Engineer, when collecting information for the Indian Irrigation Commission. The monsoon of 1902 showed signs of fail, and as the area to be served by the project was likely to be affected, an estimate for the project was hurriedly prepared for Rs. 1,45,393 on protective lines approved by the Commission and sanctioned by the Government of India in their letter No. 85-CW., dated the 23rd January, 1903

The original project, as already mentioned was put together hurriedly on rather meagre data, and further investigation, together with additions shown by later experience to be desirable, gave early indication that the original estimate was insufficient and a revised estimate amounting to Rs. 2,88,228 was, therefore, submitted and sanctioned in Government of India No. 674-1, dated the 20th May 1907

Again in the year 1807-08 owing to deficient rainfall in the Tirora Tahsil, and anticipation of the necessity of relief works, a Left Bank channel was projected, and a second revised estimte including this addition and amounting to Rs. 4,48,228 was put forward and provisionally sanctioned in the Government of India No. 853-1, dated the 21st April 1908 with the recommendation that work should be commenced without waiting for detailed estimate. On completion of the last, it was again found necessary to increase the amount of Rs. 5,39,277 which together with an additional amount of Rs. 14,000 added by the

Government of India, was sanctioned in Government of India No. 106-1, dated the 16th February 1910 bringing the total estimated cost of the project up to Rs. 5,53,277

Ultimately it was found necessary to put up a supplementary estimate in order to cover the excess incurred in the acquisition of land, for the strengthening of certain masonry works, and for provision of a further few masonry works

(2) Personnel

1. Mr. W. B. Starky, Executive Engineer
2. Mr. W. H. Halifax, Temporary Engineer
3. Mr. B. N. Sarkar, Assistant Engineer
4. Captain H. De L. Pollard-Lowsley, R.E., C.I.E.
5. Captain A. ff. Gartett, R.E.
6. Rai Sahib S. N. Bhaduri, Temporary Engineer

(3) Bibliography

Public Works Department Central Provinces " Completion Report of the Khairbanda Tank "

VI. 5. Chandpur Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	62·3 feet
(2) Location	Bhandara District, Madhya Pradesh (Chandpur Nala)
(3) Authority or owner	Madhya Pradesh Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1905
(6) Year of completion	1915
(7) Capital cost	
(*a*) Estimated	
(*b*) Actual	Rs. 2,01, (Works only)
(8) Culturable area commanded by the project	28,686 acres
(9) Area irrigated	10,891 acres
(11) Means of access	The Chandpur tank is situated 15 miles north of the Tumsar Road station of the Bengal-Nagpur Railway in the Bhandara District

II. GEOPHYSICAL

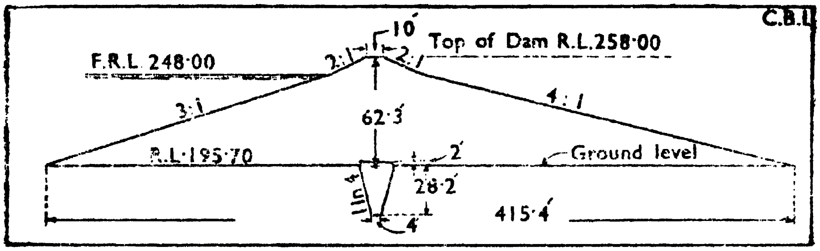
(1) Area of catchment	28 square miles
(2) Nature of catchment	The catchment area is fairly hilly and covered with thick jungle
(3) Mean annual precipitation	
(*a*) Rainfall	47·36 inches
(4) Total average annual yield of the catchment	30,165 acre feet
(5) Climate	Tropical
(6) Temperature conditions and variations	Maximum temperature 118°F. and variation of 25°F

(7) Rate of Flow	
(*a*) **Maximum**	
(*b*) **Minimum**	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	Clear for eight months and silt laden for four months
(10) Geological features	
(*a*) of foundations	
(*b*) of catchment area	Gneiss rock much disintegrated

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M. W. L.	
(*b*) F. R. L.	R. L. 248·00
(*c*) Area at M. W. L.	
(*d*) Area at F. R. L.	2·69 square miles
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	26,561 acre feet
(*b*) Live	26,423 acre feet
(*c*) Flood storage	
(*d*) Carry-over	9,757 acre feet



Cross Section of Chandpur Dam.

(3) Maximum height above the lowest point of foundations	90·5 feet
(4) Height above the lowest river bed at dam	62·2 feet
(5) Height of the top of the dam above the crest of the spillway or weir	10 feet

(6) Maximum width at level of foundations	415·4 feet
(7) Width at top	10 feet
(8) Batter of face slopes	
(*a*) Upstream	2 to 1 and 3 to 1
(*b*) Downstream	2 to 1 and 4 to 1
(9) Length of top of the dam	
(*a*) Non-overflow	
(*i*) Main	Main 611 feet, lower Dam 950 feet
(*ii*) Subsidiary	1,570 feet
(*b*) Spillway	123·0 feet and 200 feet
(10) Cubic volume of the body of the dam	3,760,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Soft shale
(12) Specific gravity	
(*a*) Earthfill	
(13) Nature of protection and waterproofing of the upstream and downstream faces	Stone pitching on upstream face
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundations of the dam	By means of core wall
(21) Hydraulic gradient for which the embankment is designed	4 : 1
(22) Particular of the berm (if any), width and position	
(23) Position and form of the core-wall (or other means of securing water tightness)	As per cross section
(24) Batter (if any) of the core-wall	1 in 4
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	28·2 feet
(26) Method of keying core-wall or other wall in the underlying ground	Puddle trench
(27) Nature of material forming the core or other wall	Puddle

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory
(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads :
    (*i*) Highways
    (*ii*) District Roads
    (*iii*) Village Roads
  (*e*) Railway Lines
  (*f*) Temples, mosques, *etc.*
  (*g*) Graves, *etc.*
  (*h*) Trees, gardens, pastures, houses, wells, *etc.*
  (*i*) Bridges
(3) Compensation paid under each category of item (2)
(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Two flank waste weirs 123 feet and 20 feet long respectively for main tank and are 76 feet long for the low level tank
(2) Outlet works	Three sluice valves each 2 feet 6 inches diameter
(3) Scouring works	
(4) Inspection facilites	Sluice tower and tunnel under embankment accessible for inspection
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features
(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents	
(4) Operation of the dam	
(a) Regulation	
(b) Silting of the reservoir	
(i) Total silt deposited	1,172·5 acre feet
(ii) Rate of silting	53·26 acre feet (annually)
(iii) Density of the silt deposited	
(iv) Rate of advancement of delta	
(c) Actual yield as against estimated	
(d) Various measurements and observations	
(i) Evaporation losses	
(ii) Sweating below the dam	
(iii) Temperature measurements	
(iv) Seepage and regeneration	
(e) Fish culture	
(f) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	

IX.—BIBLIOGRAPHY AND HISTORICAL

(1) *Historical*	The scheme was originally proposed by Mr. G. S. Morley, Executive Engineer, in 1901. Work was started in 1905, and irrigation began in 1908, when the channels were partially made. The estimate was closed in September 1915 after completion of all the distributaries. The scheme as finally accepted in Government of India's letter No. 1036-I dated the 4th October, 1912 provided for the irrigation of 12,000 acres of rice and 4,000 acres of wheat at a cost of Rs. 6,77,012 sanctioned as follows, *viz.*, Rs. 5,91,553 by letter No. 2017-I dated the 30th September 1908, and Rs. 85,729 by letter No. 1036-I, dated the 4th October, 1912

The scheme, as originally framed was designed to irrigate 7,800 acres of rice, not followed by a *rabi* crop and to protect this area completely in good and bad years. But under the advice of Sir John Benton, Inspector General of Irrigation, the scope of the scheme was augmented and the distributaries were extended to spread the benefits of irrigation further afield, and to provide for *rabi* irrigation

(2) Personnel

1. Mr. G. S. Morley, Executive Engineer
2. Captain H. de L. Pollar-Lowsley, R. E.
3. Captain A. ff. Garrett, R. E.
4. H. W. Hallifax
5. Rai Sahib S. N. Bhandari
6. Mr. W. H. Todd
7. G. H. Forrest
8. Mr. K. P. Ugrasinhs Rao, Temporary Upper Subordinate

(3) Bibliography

Public Works Department, Central Provinces "Completion report of the Chandpur irrigation tank in the Bhandara District of the Central Provinces "

VI. 6. Asola Mendha Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	59·3 feet
(2) Location	Chanda District, Madhya Pradesh (Pathri river).
(3) Authority or owner	Madhya Pradesh Government
(4) Purpose-Main and subsidiary	Irrigation
(5) Year of commencement	1903
(6) Year of completion	1918
(7) Capital cost	
(*a*) Estimated	Rs. 6,20,000 head works.
(*b*) Actual	Rs. 6,01,211
(8) Culturable area commanded by the project	121,300 acres
(9) Area irrigated	24,500 acres
(11) Means of access	It is accessible from Rajoli Railways Station 8 miles distant from the dam site. .

II. GEOPHYSICAL

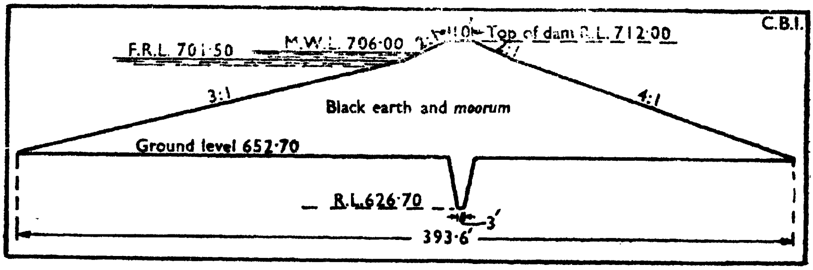
(1) Area of catchment	94·8 square miles
(2) Nature of catchment	Moderately steep
(3) Mean annual precipitation	
(*a*) Rainfall	45·14 inches
(4) Total average annual yield of the catchment	93,802 acre feet
(5) Climate	Tropical
(6) Temperature conditions and variations	Maximum temperature in summer 115°F to 120°F Maximum temperature in winter 70°F to 80°F Average daily variation 20°F.

(7) Rate of flow	
(*a*) Maximum	3,668 cusecs (abnormal flow in 1949 5,847 cusecs).
(*b*) Minimum	Normal 2,185 cusecs.
(8) Detritus charge of the stream	Clear and clean for eight months and silt laden for four months.
(9) Character (chemical) of the water stored in the reservoir.	
(10) Geological features	
(*a*) of foundations	Crystalline rocks
(*b*) of catchment area	Light crystalline

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M.W.L.	R.L. 706·0
(*b*) F.R.L.	R.L. 701·5
(*c*) Area at M.W.L.	7·82 square miles
(*d*) Area at F.R.L.	7·26 square miles
(*e*) Maximum length	4·75 miles
(*f*) Maximum width	2·90 miles
(*g*) Length of periphery	21·65 miles
(2) Capacity of the reservoir	
(*a*) Gross	75,367 acre feet
(*b*) Live	60,491 acre feet
(*c*) Flood storage	97,429 acre feet
(*d*) Carry over	97,429 acre feet



Cross Section of Asola Mendha Dam

(3) Maximum height above the lowest point of foundations	85·3 feet
(4) Height above the lowest river bed at dam	59·3 feet

(5) Height of the top of the dam above the crest of the spill-way or weir	10·5 feet
(6) Maximum width at level of foundations	393·6 feet (346 feet excluding berms).
(7) Width at top	10 feet.
(8) Slopes	
(*a*) Upstream	1 : 2 and 1 : 3
(*b*) Downstream	1 : 1½ and 1 : 4 with berms.
(9) Length at top of the dam	
(*a*) Non-overflow	
(*i*) Main	4,515 feet
(*ii*) Subsidiary	1,815 feet 1,650 feet 200 feet
(*b*) Spillway	760 feet
(10) Cubic volume of the body of the dam	20,915,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Black earth and *moorum*
(12) Specific gravity	
Earthfill	1·6 to 2·0.
(13) Nature of protection and water proofing of the upstream and downstream faces	Dry stone pitching one foot thick on upstream slope only laid on 6 inches *moorum*.
(14) Provision for dealing with seepage and drainage water	Cross and longitudinal seepage drains on the downstream of puddle core.
(15) Means of securing water tightness of the foundations of the dam	By means of puddle core wall
(16) Hydraulic gradient for which the embankment is designed	1 in 4
(17) Particular of the berm (if any), width and position	Berms from R.D. 2,600 to R.D. 6,300 ranging from 25 feet to 124 feet width (Maximum).
(18) Position and form of the core wall (or other means of securing water tightness)	As per cross section
(19) Batter (if any) of the core wall.	1 in 4
(20) Maximum depth below ground surface of core-wall or other means of securing water tightness	26 feet

(26) Method of keying core-wall or other wall in the underlying ground	By means of puddle core-wall in trench
(27) Nature of material forming the core or other wall	Puddle of selected earth

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) Land submerged	
(a) Crown waste	1,466 acres (Government forest)
(b) Proprietory	3,056 acres
(2) *Dislocation*	
(a) Villages	8 Nos. partly
(b) Families	
(c) Population	
(d) Roads :	
(i) Highways	
(ii) District Roads.	
(iii) Village Roads	
(e) Railway Lines	
(f) Temples, Mosques, etc.	
(g) Graves, etc.	
(h) Trees, Gardens, Pastures, Houses, Wells, etc.	
(i) Bridges	
(3) Compensation paid under each category of item (2).	Rs. 18,862.
(4) Method of compensating for land of dispossessed landholders	In accordance with C.P. Land Acquisition Act of 1894.

V. AUXILIARY WORKS

(1) Surplussing works	There is only one waste weir of the flushbar type on the west, away from the bund ; the length being 760 feet and designed to carry 4·5 feet depth of water over crest and discharge of 22,121 cusecs.
(2) Outlet works	The sluice is situtaed at R.D. 8800 on the East flank dam. It consists of four square openings 4 feet by 4 feet and calculated to discharge 339 cusecs with 1 foot head and is constructed of brick masonry. The penstock gates are fixed into ashlar masonry by means of Lewis bolts and are operated with screw gearing fixed at top of the sluice head wall.

(4) Inspection facilities	Sluice lower accessible for inspection by approach bridge.
(5) Fish pass	
(6) Means for dissipating energy below the spillway.	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	One main bund with three subsidiary bunds and sluice outlet with four gates of 4 feet by 4 feet and flush waste weir with 4 falls in spill channel.
(2) Changes introduced in the plans of the dam and the method of carrying out the work	
(3) Noteworthy occurrences and accidents	The reservoir is formed by a main and two flank dams. The main dam breached in 1910 and hence to prevent the dam breaching third flank had to be subsequently constructed.
(4) Operation of the dam	
(*a*) Regulation	Operated with screw gearing fixed at top of sluice wall
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	
(*d*) Various measurments and observations	
(*i*) Evaporation losses	Maximum upto 4·5 feet depth during the year
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	No fish culture is being done. However, fishing rights are leased out.
(*f*) Anti malaria measures	
(5) Recreation facilities	

(6) Lessons to be learnt from the construction and utilisation of the dam	The tank was designed for 30,000 acres *kharif* and 30,000 acres *rabi* and for this a capacity of 2,635 million cubic feet upto F.R.L. was provided. Main channel was designed for 339 cusecs at a duty 100 acres per cusec. Against this it is seen that maximum area brought under agreement is only 19,000 acres. The estimated 60,000 acres were made up of 45,000 acres under *malguzar* land, 5,000 under *raiyatwari* and 10,000 under forest land. Further 45,000 acres *malguzari* land were made up of 17,000 acres already cropped and 28,000 expected expansion. Maximum 19,000 is made up of 17,000 acres under *Malguzari* and 2,000 under *raiyatwari* and none under forest land. It will, therefore, be seen that there has been very little expansion during the past 40 years, being practically nil in *malguzari* and forest lands. The latter can easily be understood as it involves a great deal of labour in disforesting while in the case of the former it can only be said that a maximum limit has been reached to which the population of *malguzari* land can be expected to be cultivated. For further expansion organised effort to stimulate cultivation for over populated areas is essential. A step in this direction has been taken by the Government, by settling some families in the Vehad reserved forest block and eventually additional 3,000 acres are proposed to be brought under plough. Similar organised effort alone can increase the area but it will be too optimistic to hope that 60,000 acres will ever be irrigated.

The work was classified as productive at the time of its construction. Revenue statistics for 20 years from 1880 to 1899 show that it is protective work.

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

It was undertaken to provide labour during the distress of 1902-03. Sanction to its construction as a protective work was conveyed in the Government of India's letter No. 346-C-I, dated March 6, 1903. The estimate was again revised in accordance with the instructions of Inspector General of Irrigation and the estimate of the project was sanctioned as a productive work by the Secretary of States in September 1910.

(2) Personnel

1. Col. S. G. Rivett Carnace, R.E., Secretary to the Chief Commissioner, Central Provinces.
2. Shri E.S.L. Beddy, Superintending Engineer, Wainganga Circle.
3. Shri A. B. Madapa, Ex. Engineer, Mul Irrigation Division.

(3) Bibliography

Public Works Department, Central Provinces, " Completion Report of the Asola Mendha tank in the Chanda District ".

VI. 7. Jumania Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	50·5 feet
(2) Location	Balaghat District, Madhya Pradesh, Dodha Nala.
(3) Authority or owner	Madhya Pradesh Government
(4) Purpose Main and subsidiary	Irrigation
(5) Year of commencement	1912
(6) Year of completion	1921
(7) Capital cost	
(a) Estimated	
(b) Actual	Rs. 2,89,695
(8) Culturable area commanded by the project	22,262 acres
(9) Area irrigated	5,858 acres
(10) Means of access	The Jumania tank is situated about six miles to the North East of Katanghi town in the Waraseoni Tehsil, Balaghat District. It is accessible, from the Katanghi railway station six miles distant from the dam site.

II. GEOPHYSICAL

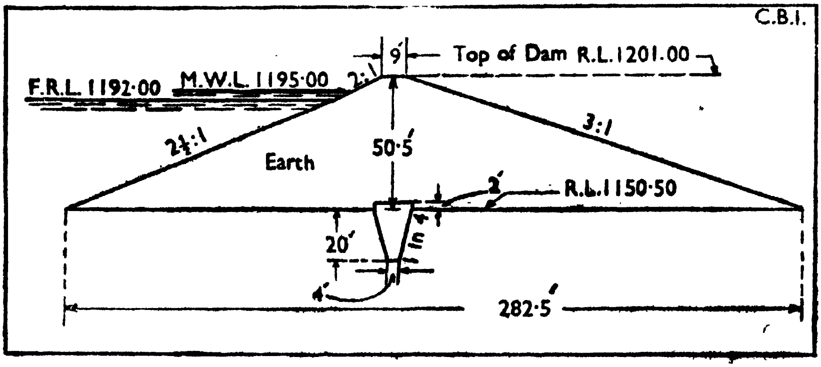
(1) Area of catchment	11·8 square miles
(2) Nature of catchment	Hilly and wooded
(3) Mean annual precipitation	
(a) Rainfall	53·03 inches
(4) Total average annual yield of the catchment	13,044 acre feet

(5) Climate	Hot with extreme variation in humidity
(6) Temperature conditions and variations	
(7) Rate of Flow	
(*a*) Maximum	
(*b*) Minimum	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	Clear for 8 months and silt laden for 4 months
(10) Geological features	
(*a*) of foundations	Founded on kankar soil (Blacksoil & Chopnaiclay calcareous loam)
(*b*) of catchment area	

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M.W.L.	R.L. 1195·00
(*b*) F.R.L.	R.L. 1192·00
(*c*) Area at M.W.L.	0·96 square mile
(*d*) Area at F.R.L.	0·9 square mile
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	7,461 acre feet
(*b*) Live	7,438 acre feet
(*c*) Flood storage	
(*d*) Carry-over	



Cross Section of Jumania Dam

(3) Maximum height above the lowest point of foundations	72·1 feet

(4) Height above the lowest river bed at dam	50·5 feet
(5) Height of the top of the dam above the crest of the spillway of weir.	9·0 feet
(6) Maximum width at level of foundation	282·25 feet
(7) Width at top	9·0 feet
(8) Slopes	
(a) Upstream	2 : 1 and 2½ : 1
(b) Downstream	3 : 1
(9) Length at top of the dam	9,096 feet main, 180 feet subsidiary dam
(a) Non-overflow	
(i) Main	8,978 feet
(ii) Subsidiary	180 feet
(b) Spillway or waste weir	118 feet
(10) Cubic volume of the body of the dam	13,000,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Earth
(12) Specific gravity	
(d) Earthfill	
(13) Nature of protection and water proofing of the upstream and downstream faces	Stone pitching on upstream and 6 inches thick rubbish of rock on the downstream
(14) Provision for dealing with seepage and drainage water	Leakage drains on downstream of bunds
(15) Means of securing water tightness of the foundations of the dam	Core-wall
(21) Hydraulic gradient for which the embankment is designed.	1 in 4
(22) Particular of the berm (if any) width and position	
(23) Position and form of the core wall (or other means of securing water tightness)	As per cross section
(24) Batter (if any) of the core wall	1 in 4 below ground level
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	21·6 feet
(26) Method of keying core-wall or other wall in the underlying ground	Puddle trench core-wall

(27) Nature of material forming the core or other wall	Puddle

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (a) Crown waste
  (b) Proprietory
(2) *Dislocation* :
  (a) Villages
  (b) Families
  (c) Population
  (d) Roads :
    (i) Highways
    (ii) District Roads
    (iii) Village Roads
  (e) Railway Lines
  (f) Temples, Mosques, etc.
  (g) Graves, etc.
  (h) Trees, gardens, pastures, houses, wells, etc.
  (i) Bridges
(3) Compensation paid under each category of item (2)
(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Waste weir 118 feet in length has 2,472 cusecs discharging capacity
(2) Outlet works (3) Scouring works	Sluice gate of iron shutters, 3 feet by 3 feet
(4) Inspection facilities	Sluice tower and tunnel under embankment accessible for inspection
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	There are five falls below the weir to prevent scour

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features
(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents	
(4) Operation of the dam	
(*a*) Regulation	By means of iron sluice gates of shutter type
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated.	Actual yield 9,668 acre feet against 13,039 acre feet estimated
(*d*) Various measurements and observations	
(*i*) Evaporation losses	826 acre feet annually
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilization of the dam	

IX. BIBLIOGRAPHY AND HISTORICAL

(1) *Historical*	The investigation of the project as Minor Work was first proposed by Mr. G. M. Harriott, Superintending Engineer, in 1905 and was made by Captain Pollard-Lowsley, R.E., Executive Engineer, who submitted in January, 1906 a preliminary estimate amounting to Rs. 129,000 for a tank of 200 million cubic feet capacity to irrigate only ten villages. In Stage II the project was designed to irrigate 5,372 acres each during *kharif* and *rabi* in 31 villages and was estimated to cost Rs. 3,20,291. This project was submitted by the Executive Engineer, Wainganga Division, in June, 1908.

The Stage III Scheme, designed to irrigate a maximum area of 7,820 acres of rice and 977 acres of wheat and estimated to cost Rs. 3,72,625 was submitted in 1910 and was sanctioned in 1911. The construction of the work was started early in 1912.

In 1917 a revised estimate was found to be necessary and was sanctioned for Rs. 3,94,708 for works only, while in 1918 a work slip for Rs. 4,01,756 was approved.

Irrigation was first started in 1915 and the construction estimate was closed in 1921, the total expenditure incurred on only works is Rs. 3,99,626.

(2) Personnel

1. Captain H. de L. Pollard Lowsley Executive Engineer.
2. Captain A.ff. Garrett, R. E. Executive Engineer.
3. Mr. Bhakt Narayan, Temporary Engineer.
4. Mr. G. S. Sneyd, Executive Engineer.
5. Mr. E.S.L. Beddy, Executive Engineer.
6. Mr. S. N. Sanyal, Assistant Engineer.
7. Rai Sahib Prayag Dass, Assistant Engineer.

(3) Bibliography

Public Works Department, Central Provinces " Completion report of the Jamunia tank ".

VI. 8. Alair (Pacharam) Dam

(Masonry)

I. GENERAL

1. Height above the lowest river bed	49 feet
2. Location	Medak district. Hyderabad State (Alair Stream)
3. Authority or owner	Hyderabad State Government
4. Purpose Main and subsidiary	Irrigation
5. Year of commencement	January, 1916
6. Year of completion	October, 1922
7. Capital cost	
(a) Estimated	Rs. 31,40,000
(b) Actual	Rs. 32,12,493
8. Culturable area commanded by the project	
9. Area irrigated	
11. Means of access	The dam is situated 18 miles away from Akkannapet Railway Station on the Secunderabad Manmad line and is also accessible by road from Hyderabad, distance 76 miles

II. GEOPHYSICAL

1. Area of catchment	240 square miles
2. Nature of catchment	

3. Mean annual precipitation	
(*a*) Rain fall	35·55 inches
4. Total average annual yield of the catchment	77,700 acre feet
5. Climate	Tropical
6. Temperature conditions and Variations	Maximum temperature 106·2° F. Minimum temperature 56·4° F.
7. Rate of Flow	
(*a*) Maximum	23,240 cusecs
(*b*) Minimum	Negligible
8. Detritus charge of the stream	Lighter particles of silt are carried forward in the water as turbid matter during floods. No boulders are carried along the bed
9. Character (chemical) of the water stored in the reservoir	Soft water suitable for domestic and irrigation purposes
10. Geological features	
(*a*) of foundations	Granite and trap dyke
(*b*) of catchment area	Granite

III. TECHNICAL

A. STATISTICAL

1. Reservoir Data	
(*a*) M.W.L.	R.L. 1469·00
(*b*) F.R.L.	R.L. 1464·00
(*c*) Area at M.W.L.	7·5 Square miles
(*d*) Area at F.R.L.	6·5 square miles
(*e*) Maximum length.	
(*f*) Maximum width.	
(*g*) Length of periphery	

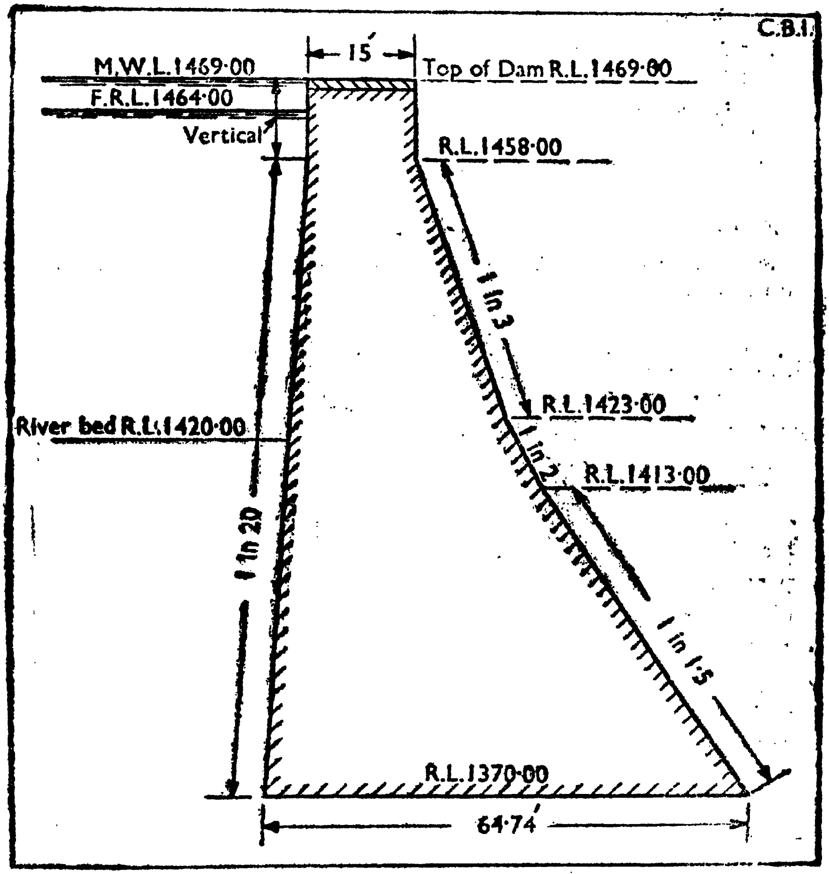
2. Capacity of the reservoir

(*a*) Gross

(*b*) Live 55,280 acre feet

(*c*) Flood storage

(*d*) Carry over



Cross Section of Alair Dam

3. Maximum height above the lowest point of foundation	99 feet
4. Height above the lowest river bed at dam	49 feet
5. Height of the top of the dam above the crest of the spillway or weir	5 feet

6. Maximum width at level of foundation	64·74 feet
7. Width at top	15 feet
8. Slopes	
(a) Upstream (b) Downstream	As per cross section
9. Length at top of the dam	2,100 feet
(a) Non overflow Main	200 feet
(b) Spillway or waste weir	1,900 feet
10. Cubic volume of the body of the dam	2,840,000 cubic feet

B. OTHERS

11. Material of which the dam is constructed	Uncoursed rubble stone masonry in *surkhi* Mortar for face work and hearting with block in course rubble stone masonry
12. Specific gravity Masonry	2·25
(13) Nature of protection and water proofing of the upstream and downstream faces?	
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundations of the dam	No special measures
(16) Contraction joints	
(17) Principal stresses in the masonry with a note of methods of calculations employed	The dam was designed as a gravity dam of rubble masonry with a maximum stress allowed for was about 9·5 tons per square foot
(18) Maximum pressure on foundations	
(19) Uplift pressure, calculated or measured	The dam rests on impervious rock
(20) Measures adopted for preventing or counteracting uplift pressures	No allowance has been made for uplift pressure

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*

(a) Crown waste

(b) Proprietory

(2) Dislocation

- **(a) Villages**
- **(b) Families**
- **(c) Population**
- **(d) Roads :**
  - **(i) Highways**
  - **(ii) District Roads**
  - **(iii) Village Roads**
- **(e) Railway Lines**
- **(f) Temples, Mosques, etc.**
- **(g) Graves, etc.**
- **(h) Trees, gardens, pastures, houses, wells, etc.**
- **(i) Bridges**

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Surplussing works (i) Right Flank Weir 6,00 feet in length (ii) Left Flank Weir 800 feet in length (iii) Free overfall weir 500 feet in length
(2) Outlet works	Head Sluices of 4 vents each 3 feet by 3 feet
(3) Scouring works	Scouring sluice, of 15 vents each 4 feet by 6 feet
(4) Inspection facilities	
(5) Fish pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	The work was done partly by department and partly by contract agency. It was completed in 6 years duration.

(2) Changes introduced in the plans of the dam and in the method of carrying out the work	(*i*) The foundations of the dam were taken down to a much lower depth than that estimated for, in order to seat the dam on sound rock. (*ii*) The present impounding capacity of the stream being 2,633 million cubic feet or 60,446 acre feet instead of 1,167 million cubic feet or 26,791 acre feet as originally proposed, was considered economical to increase to present capacity of the reservoir and hence while carrying out the work, the Full Reservoir Level was raised by 8 feet. (*iii*) Scouring sluices consisting of 15 vents each 4 feet by 6 feet were introduced to prolong life of the reservoir.
(3) Noteworthy occurrences and accidents	
(4) Operation of the dam	
(*a*) Regulation	
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yeild as against estimated	
(*d*) Various measurements and observations	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	

(*f*) Anti-malaria measures	
(5) Recreation facilities	
6) Lessons to be learnt from the construction and utilisation of the dam	It was found that the material required for the construction and labour, if available locally, can give comparatively cheaper results

IX. BIBLIOGRAPHY AND HISTORICAL

1) Historical	
2) Personnel	Nawab Ali Nawaz Jung Bahadur F.C.H. Chief Engineer.
3) Bibliography	

VI. 9. Ghorajheri Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	65·75 feet
(2) Location	Chanda District, Madhya Pradesh (Bokardoh Nala)
(3) Authority or owner	Madhya Pradesh Government
(4) Purpose-Main and subsidiary	Irrigation
(5) Year of commencement	1905
(6) Year of completion	1923
(7) Capital cost	
(*a*) Estimated	Rs. 1,66,778 (Headworks only)
(*b*) Actual	Rs. 1,79,841 (works only)
(8) Culturable area commanded by the project	31,795 acres
(9) Area irrigated	4,308 acres
(11) Means of access	It is accessible by road from Nagbhir B. N. Railway station which is at a distance of 7 miles

II. GEOPHYSICAL

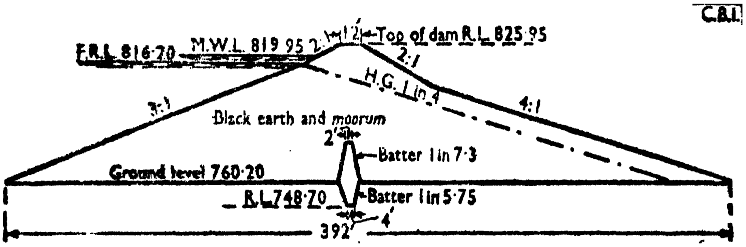
(1) Area of catchment	35 square miles
(2) Nature of catchment	Steepy
(3) Mean annual precipitation	
(*a*) rainfall	50·6 inches
(4) Total average annual yield of the catchment	42,218 acre feet
(5) Climate	Tropical
(6) Temperature conditions and variations	Maximum temperature 115° F to 120° F. Minimum temperature 70° F to 80° F.

(7) Rate of flow	
(a) Maximum	9,708 cusecs
(b) Minimum	
Detritus charge of the stream	Clear for 8 months and silt laden for 4 months
9) Character (chemical) of the water stored in the reservoir	
10) Geological features	
(a) of foundations (b) of catchment	Vindhyan Sand-stone fairly horizontally bedded

III. TECHNICAL

A. STATISTICAL

1) Reservoir Data	
(a) M.W.L.	R.L. 819·95
(b) F.R.L.	R.L. 816·20
(c) Area at M.W.L.	4·37 square miles
(d) Area at F.R.L.	3·77 square miles
(e) Maximum length	3·6 miles
(f) Maximum width	2·4 miles
(g) Length of periphery	17 miles
(2) Capacity of the reservoir	
(a) Gross	36,652 acre feet
(b) Live	30,836 acre feet (available)
(c) Flood storage	



Cross Section of Ghorajheri Dam

(3) Maximum height above the lowest point of foundations	**77·25 feet**
4) Height above the lowest river bed (at dam)	**65·75 feet**

(5) Height of the top of the dam above the crest of the spillway or weir	9·75 feet
(6) Maximum width at level of foundation	392 feet
(7) Width at top	12 feet
(8) Slopes	
(a) Upstream	2 : 1, 2½ : 1 and 3 : 1
(b) Downstream	2 : 1 and 4 :1 (Hydraulic berms)
(9) Length at the top of the dam	3,910 feet
(a) Non-overflow	
(i) Main	2,400 feet
(ii) Subsidiary	1,100 feet
(b) Spillway	410 feet clear-overfall
(10) Cubic volume of the body of the dam	5,194,960 cubic feet

B. OTHERS

(11) Materials of which the dam is constructed	Black earth and moorum
(12) Specific gravity	
Earth-fill	1·6 to 2·0
(13) Nature of protection and water proofing of the upstream and downstream faces	Dry stone pitching one foot thick on 6 inches quarry spawls on upstream side only
(14) Provision for dealing with seepage and drainage water	Cross and longitudinal seepage drains downstream of puddle core
(15) Means of securing water tightness of the foundations of the dam	By means of puddle core-wall
(21) Hydraulic gradient for which the embankment is designed	1 in 4
(22) Particular of the berm (if any) width and position	Berms from R.D. 2,200 to 2,800 width ranging from 20 feet to 120 feet
(23) Position and form of the core-wall (or other means of securing water tightness)	As per cross section
(24) Batter (if any) of the core-wall	Below ground level 1 in 3·75 and above ground level 1 in 7·33
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	11·5 feet
(26) Method of keying core-wall or other wall in the underlying ground	Puddle trench

(27) Nature of material forming the core or other wall.	Puddle

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) Land submerged	
(a) Crown waste	4,201 acres (Government Forests)
(b) Proprietory	
(2) Dislocation	
(a) Villages	
(b) Families	
(c) Population	
(d) Roads	
(i) Highways	
(ii) District Roads	
(iii) Village Roads	
(e) Railway Lines	
(f) Temples, mosques, *etc.*	
(g) Graves, *etc.*	
(h) Trees, gardens, pastures, houses, wells, *etc.*	
(i) Bridges	
(3) Compensation paid under each category of item (2)	
(4) Method of compensating for land of dispossessed landholders	In accordance with Central Provinces Land Acquisition Act of 1894

V. AUXILIARY WORKS

(1) Surplussing works	Waste weir having discharging capacity of 11,300 cusecs
(2) Outlet works (3) Scouring works	Penstock type
(4) Inspection facilities	Sluice tower and tunnel under embankment accessible for inspection
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	Head works comprises—Earthen dams with one sluice with 2 penstock gates 4 feet by 4 feet and masonry overfall waste weir with spill channels in rock and hard moorum. Main channel is lined with cement concrete lining at places.

(2) Changes introduced in the plans of the dam and in the method of carrying out the work	Except for non-provision of drop shutter on waste weir at the time of construction the rest of the work was executed as per plans.
(3) Note worthy occurrences and accidents	
(4) Operation of the dam	
(*a*) Regulation	By manual labour
(*b*) Silting of the reservoir	
(*i*) total silt deposited	
(*ii*) rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta.	
(*c*) Actual yeild as against estimated	
(*d*) Various measurements and observations	
(*i*) Evaporation losses	4½ feet in the whole year
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	No fish culture is being done. Fishing rights are, however, leased out every year.
(*f*) Anti-malaria measures	
(5) Recreation facilities	Hunting and small games
(6) Lessons to be learnt from the construction and utilisation of the dam	Area-Designed 10,000 acres dry 3,000 acres wet 500 acres sugarcane 1912-13—1,146+71 ; 1920-21—7,598+169 ; 1925-26—5,539+224 ; 1948-49—9,349+120. Total area commanded is 48,429 acres, out of which 5,572 is unculturable and 10,872 jungle leaving 31,985 acres culturable. Out of these 31,985 acres, 10,703 acres are wet leaving 21,282 acres as dry culturable area.

The tank was originally designed for 18,000 acres and it was anticipated that by 1930-31 an area of 10,000 acres dry and 3,000 acres wet would come under agreement but the above figures of irrigated area show that to this day the maximum area under agreement is only 9,34 acres. Expansion as anticipated has not been achieved in spite of the fact that cultivators have realised the advantages of irrigation and the grains prices having gone up considerably. This is due to the fact that best soils and best position of rice fields have already been brought under plough and embankment of new fields on sloping ground is expensive.

Since the full area of rice was not forthcoming, sugarcane cultivation was allowed under this tank, this has had to be discontinued as it entailed in almost continuous ruins of the channel and thereby deteriorating their conditions.

Channels pass through very light soil and in upper reaches through boulder and moorum and fissured rocks. This resulted in excessive losses in the canals specially at the time of sugarcane irrigation being as much as 75 per cent. In order to stop this, the channel was lined with six inches lime concrete laid on three inches rammed gitti and moorum and the losses brought down to 25 per cent. Due to the continuous use of the channel the lining has given way in many reaches resulting in considerable leakage of water. The only alternative seems to be to stop sugarcane irrigation.

Work was designed as a protection work and will remain so.

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

The scheme was originally proposed and investigated for the Indian Irrigation Commission of 1902. The project was submitted to the Government and sanctioned in 1905 as a protective work. Estimate amounted to Rs. 3,35,750 for works only and Rs. 5,55,031 including all charges. The project was designed to protect 10,930 acres of rice in 23 villages. It was subsequently sanctioned in 1908 for Rs. 6,54,911 (for works) and Rs. 8,32,784 (for all charges) to protect 15,688 acres, rice and 10,312 acres *rabi* crops.

On the advice of Inspector General of irrigation supplementary estimate was sanctioned with certain modifications in the design of the embankment and increase in the freeboard of the canal system in 1912 increasing the cost to Rs. 7,59,710/- for works only and Rs. 9,66,958/- (for all charges). In 1915 the estimate was again revised to Rs. 9,84,377 (works) and 12,37,507 (all charges) to incorporate the cost of lining the channels. In March 1923 the work was practically completed and construction estimate closed.

(2) Personnel

Mr. G. M. Harriott Superintending Engineer, irrigation Branch. Shri B. N. Sarkar, Assistant Engineer and Shri S. N. Bhaduri and Bhaktnarain Ty. Engineers.

The work was completed in the incumbency of Col. H. Del. L. Pollard Lowsley. Chief Engineer Irrigation Branch and Shri E. L. Glass as Superintending Engineer.

(3) Bibliography

Public Works Department Irrigation Branch Completion Report of Ghorajheri tank in Chanda District.

VI. 10. Sarathi (Earthen) Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	58·0 feet	
(2) Location	Balaghat District, Madhya Pradesh, Sarathi *Nala*	
(3) Authority or onwer	Madhya Pradesh Government	
(4) Purpose—Main and subsidiary	Irrigation	
(5) Year of commencement	1912	
(6) Year of completion	1923	
(7) Capital cost		
(*a*) Estimated	Rs. 4,55,517	(Works only)
(*b*) Actual	Rs. 4,78,778	
(8) Culturable area commanded by the project	16,868 acres	
(9) Area irrigated	8,995 acres	
(11) Means of access	It is accessible by road from Samnapur railway station on the main line of Bengal Nagpur Railway in Balaghat District.	

II. GEOPHYSICAL

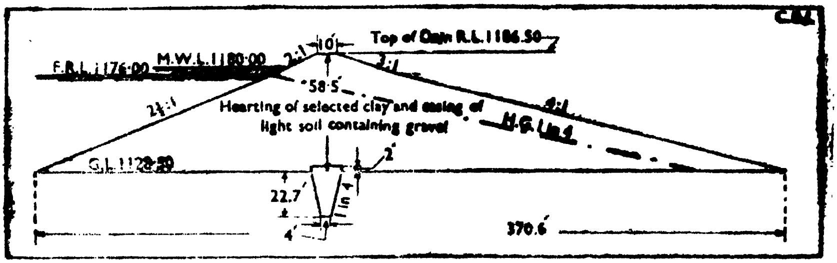
(1) Area of catchment	37·75 square miles
(2) Nature of catchment	Steepy and wooded
(3) Mean annual precipitation	
(*a*) Rainfall	47·57 inches
(*b*) Snow	
(4) Total average annual yeild of the catchment	41,001 acre feet (By Binner's percentage)
(5) Climate	Hot
(6) Temperature conditions and variations	There is extreme variation in humidity.

(7) Rate of Flow	
(*a*) Maximum	
(*b*) Minimum	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	Water clear for 8 months and silt particles flow for 4 months
(10) Geological features	
(*a*) of foundations	Disintegrated crystalline rock
(*b*) of catchment area	Slopes are steep and wooded

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M.W.L.	R.L. 1180·5
(*b*) F.R.L.	R.L. 1176·00
(*c*) Area at M.W.L.	1·41 square miles
(*d*) Area at F.R.L.	1·27 square miles
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	13,827 acre feet
(*b*) Live	13,113 acre feet (available)
(*c*) Flood storage	
(*d*) Carry-over	4,178 acre (Average of 10 years)



Cross Section of Sarathi Dam

(3) Maximum height above the lowest point of foundations	80·7 feet
(4) Height above the lowest river bed at dam	58·00
(5) Height of the top of the dam above the crest of the spillway or weir	10·5 feet

(6) Maximum width at level of foundations	370·6 feet
(7) Width at top	8 feet to 10 feet (according to height of dam)
(8) Slopes	
(*a*) Upstream	2 : 1 and 2½ : 1
(*b*) Downstream	3 : 1 and 4 : 1
(9) Length at top of the dam	6,543 feet
(*a*) Non-overflow	
(*i*) Main	6,150 feet
(*ii*) Subsidiary	
(*b*) Spillway	393 feet
(10) Cubic volume of the body of the dam	2,00,50,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Hearting of selected clay and casing of light soil containing gravel
(12) Specific gravity	
(13) Nature of protection and water-proofing of the upstream and downstream faces	Pitching on upstream and 6 inches rubbish of rock on the downstream
(14) Provision for dealing with seepage and drainage water	Leakage drains are provided on downstream of *bund*.
(15) Means of securing water tightness of the foundations of the dam	By means of core-wall
(21) Hydraulic gradient for which the embankment is designed	1 in 4
(22) Particular of the berm (if any) width and position	
(23) Position and form of the core wall (or other means of securing water tightness)	As per sketch
(24) Batter (if any) of the core-wall	1 in 4 below ground level
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	22·7 feet as per sketch
(26) Method of keying core-wall or other wall in the underlying ground	Puddle trench
(27) Nature of material forming the core or other wall	Puddle

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory

(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads
    (*i*) Highways
    (*ii*) District Roads
    (*iii*) Village Roads
  (*e*) Railway Lines
  (*f*) Temples, mosques, etc.
  (*g*) Graves, etc.
  (*h*) Trees, gardens, pastures, houses, wells, etc.
  (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Waste weir is a clear overfall with 5 falls in spill channel to prevent scour. Length of the weir is 393·0 feet.
(2) Outlet works	Two sluice gates with ordinary iron shutters, 2'×1½' & 4'×4'
(3) Scouring works	
(4) Inspection facilities	Sluice tower and tunnel under embankment, accessible for inspection
(5) Fish-pass	*Nil*
(6) Means for dissipating energy below the spillway	Spillway channel has been provided with 5 falls to prevent scour downstream of the weir.

VIII. SUPPLEMENTARY INFORMATION

1) Constructional features	The material used in the construction of the embankment is chiefly " *burra* " soil, which is light one. It contains some gravel. The inner core is of selected clay and has a top width of 5 feet and side slopes of 3 in 2. A puddle trench, generally 4 feet wide at the bottom with side slopes 1 in 4 is provided throughout the length of the dam to depths of about half the height of highest flood level, above the ground level, except in the sandy bed of the *Nala*.
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurrences and accidents	
(4) Operation of the dam	
(*a*) Regulation	By means of iron sluice gates of shutter type
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	1561·3 acre feet
(*ii*) Rate of silting	70·96 acre feet (annually)
(*iii*) Density of the silt deposited	Record not available
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	1825 Mcft i.e. (average of 10 years) as against 178·6 Mcft estimated
(*d*) Various measurements and observations	
(*i*) Evaporation losses	124 Million cubic feet yearly (Average of 10 years)
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

This work was first investigated as an independent tank scheme in 1905; it was included in the Wainganga Canal Project in 1910 as a storage reservoir for the irrigation of *rabi*, and was finally designed as an independent work when it was decided in 1914 that it was not required to assist the canal. This work commands land on both banks of the Sarathi Nala, bounded on the east by the Wainganga Canal and on the south by the areas irrigated from the Kamptee and Pathri tanks.

(2) Personnel

(3) Bibliography

Public Works Department Central Provinces, " Completion report of the Wainganga Canal Project " in the Balaghat District.

VI. 11. Chorkhamara Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	60·6 feet
(2) Location	Madhya Pradesh Bhandara District, Chorkhamara Nala
(3) Authority or owner	Madhya Pradesh Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1911
(6) Year of completion	1923
(7) Capital cost	
(*a*) Estimated	
(*b*) Actual (dam work only)	Rs. 4,17,068 (includes Rs. 15,186 on account of extraordinary replacement)
(8) Culturable area commanded by the project	32,730 acres
(9) Area irrigated	6,690 acres
(10) Installed hydro-electric capacity	
(*a*) Firm	
(*b*) Secondary	
(11) Means of access	It is accessible from Tirora Railway Station on the Bengal-Nagpur Railway. The Tirora Railway Station is about 9 miles North East of dam site.

II. GEOPHYSICAL

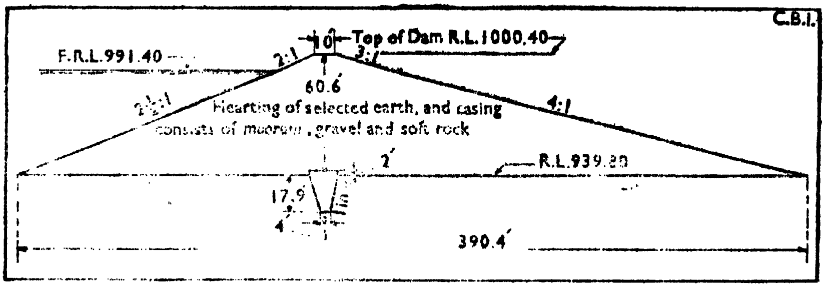
(1) Area of catchment	29·0 square miles
(2) Nature of catchment	Fairly steep slopes
(3) Mean annual precipitation	
(*a*) Rainfall	49·9 inches
(*b*) Snow	

(4) Total Average annual yield of the catchment	34,159 acre feet
(5) Climate	Tropical
(6) Temperature conditions and variations	Maximum temperature 118°F, with variations of 25°F.
7) Rate of Flow	
(a) Maximum	
(b) Minimum	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	It is clear for 8 months and silt laden for 4 months.
10) Geological features	
(a) of foundations	Dharwar formation
(b) of catchment area	Hilly
(11) Earthquake (Zone and intensities)	

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(a) M. W. L.	994·40
(b) F. R. L.	991·40
(c) Area at M.W.L.	
(d) Area at F.R.L.	1·94 square miles
(e) Maximum length	
(f) Maximum width	
(g) Length of periphery	
(2) Capacity of the reservoir	
(a) Gross	18,085 acre feet
(b) Live	17,883 acre feet
(c) Flood storage	
(d) Carry-over	



Cross section of Chorkhamara Dam

(3) Maximum height above the lowest point of foundations	78·5 feet
(4) Height above the lowest river bed at dam	60·6 feet
(5) Height of the top of the dam above the crest of the spillway or weir	
(6) Maximum width at level of foundation	390·4 as per sketch calculated.
(7) Width at top	10 feet
(8) Slopes	
(*a*) Upstream	2 : 1 and 2½ : 1
(*b*) Downstream	3 : 1 and 4 : 1
(9) Length at top of the dam	3,833 feet
(*a*) Non-overflow	
(*i*) Main	3,323 feet
(*ii*) Subsidiary	1,295 feet
(*b*) Spillway	510 feet
(10) Cubic volume of the body of the dam	13,440,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Hearting of selected earth, and casing consists of *moorum* gravel and soft rock
(12) Specific gravity	
(*a*) Masonry	
(*b*) Concrete	
(*c*) Rockfill	
(*d*) Earthfill	
(13) Nature of protection and waterproofing of the upstream and downstream faces	This inner slope is protected by a 12-inch depth of stone pitching laid on a 3-inch soiling of quarry spawls
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundations of the dam	By means of core-wall
(21) Hydraulic gradient for which the embankment is designed	
(22) Particular of the berm (if any) width and position	

(23) Position and form of the core wall (or other means of securing water tightness)	As per sketch
(24) Batter (if any)of the core-wall	1 in 4
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	17·9 feet
(26) Method of keying core-wall or other wall in the underlying ground	Puddle trench
(27) Nature of material forming the core or other wall	Puddle

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  - (*a*) Crown waste
  - (*b*) Proprietory

(2) *Dislocation*
  - (*a*) Villages
  - (*b*) Families
  - (*c*) Population
  - (*d*) Roads
    - (*i*) Highways
    - (*ii*) District Roads
    - (*iii*) Village Roads
  - (*e*) Railway Lines
  - (*f*) Temples, mosques, etc.
  - (*g*) Graves, etc.
  - (*h*) Trees, gardens, pastures, houses, wells, etc.
  - (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Waste weir, 510 feet long has a clear overfall of 8·5 feet. Its discharging capacity of is 3,358 cusecs with a velocity of 8 feet per second.
(2) Outlet works	One sluice 4 feet × 4 feet with sluice gate
(3) Scouring works	
(4) Inspection facilities	Sluice tower and tunnel under embankment accessible for inspection.
(5) Fish-pass	

(6) Means for dissipating energy below the spillway	There are 4 falls of 6 feet each in the spill channel to prevent scour downstream of the work.

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the dam
  - (*a*) Regulation
  - (*b*) Silting of the reservoir
    - (*i*) Total silt deposited
    - (*ii*) Rate of silting
    - (*iii*) Density of the silt deposited
    - (*iv*) Rate of advancement of delta
  - (*c*) Actual yield as against estimated
  - (*d*) Various measurements and observations
    - (*i*) Evaporation losses
    - (*ii*) Sweating below the dam
    - (*iii*) Temperature measurements
    - (*iv*) Seepage and regeneration
  - (*e*) Fish culture
  - (*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and ultilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1)Historical	The scheme was first examined in the year 1902 when information regarding the possibilities of the construction of state irrigation works in the province, was collected for the Irrigation Commission. In 1907, an estimate amounting to Rs. 7,37,019 was submitted to the Government of India, but it was returned unsanctioned with instructions for the further investigation of the supply available and the area under command.

The preparation of a revised scheme was undertaken by Captain Pollard-Lowsley, R.E., and was completed by Mr. Henriques, Executive Engineer, under the direction of Major Garrett, R.E. The cost of the revised scheme was estimated to Rs. 6,79,951 (works only) and Rs. 8,65,484 inclusive of all charges. It was sanctioned by the Government of India as a protective work in 1912.

In 1913 some preliminary work was done under Mr. Ugrashinha Rao, Sub-Engineer, and in 1914 under Mr. H. Singleton, Supervisor, but a satisfactory commencement was not made until 1915. The main *nala* was closed in 1918 and the head works were completed in April 1919.

(2) Personnel

1. Mr. H. W. Hallifax, Temporary Engineer.
2. Rai Sahib S. N. Bhandari, Temporary Engineer.
3. Captain A. ff. Garett, Royal Engineer.
4. Mr. W.H. Todd, Executive Engineer
5. Mr. G. H. Forrest, Executive Engineer.
6. Mr. A. B. Madapa, Executive Engineer.
7. Mr. W. C. N. Shilstone, Executive Engineer.
8. Mr. C. Q. Henriques, Executive Engineer.
9. Mr. K. P. Ugrasinha Rao, Sub-Engineer.
10. Mr. W. Singleton, Temporary Upper Subordinate.
11. Mr. B. G. Pahlajaney, Temporary Engineer.

(3) Bibliography

Public Works Department, Central Provinces " Completion report to the Chorkhamara tank in the Bhandara District.

VI. 12. Bodalkasa Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	63·5 feet
(2) Location	Bhandara District, Madhya Pradesh (Bagdeo *Nala*)
(3) Authority or owner	Madhya Pradesh Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1911
(6) Year of completion	1923
(7) Capital cost	
(*a*) Estimated	
(*b*) Actual	Rs. 1,63,164 (works only)
(8) Culturable area commanded by the project	24,300 acres
(9) Area irrigated	6,869 acres
(11) Means of access	It is situated at a distance of 10 miles south-east of Tirora Railway Station on the Bengal Nagpur Railway

II. GEOPHYSICAL

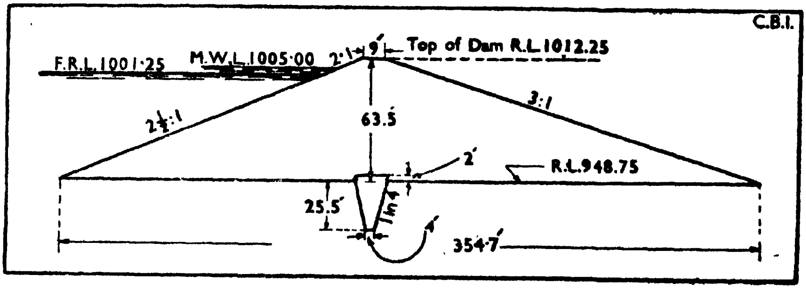
(1) Area of catchment	23·5 square miles
(2) Nature of catchment	Fairly steep slopes
(3) Mean annual precipitation	
(*a*) Rainfall	49·9 inches
(4) Total average annual yield of the catchment	27,686 acre feet
(5) Climate	Tropical
(6) Temperature conditions and variations	Maximum temperature 118°F, variation in temperature 25°F
(7) Rate of Flow	
(*a*) Maximum	
(*b*) Minimum	

(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	It is clear for eight months and silt laden for four months
(10) Geological features	
(*a*) of foundations	Dharwar formation
(*b*) of catchment area	Hilly

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M.W.L.	R.L. 1005·00
(*b*) F.R.L.	R.L. 1001·25
(*c*) Area at M.W.L.	
(*d*) Area at F.R.L.	2·2 square miles
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	16,983 acre feet
(*b*) Live	16,001 acre feet
(*c*) Flood storage	
(*d*) Carry over	



Cross section of Bodalkasa dam

(3) Maximum height above the lowest point of foundations	89·0 feet
(4) Height above the lowest river bed at dam	63·5 feet
(5) Height of the top of the dam above the crest of the spillway or weir	11 feet

(6) Maximum width at level of foundation	354·7 feet
(7) Width at top	7 feet, 8 feet and 9 feet
(8) Slopes	
(*a*) Upstream	2 : 1 and 2½ : 1
(*b*) Downstream	3 : 1 (according to height of dam)
(9) Length at top of the dam	1,700 feet
(*a*) Non overflow	
(*i*) Main	1,390 feet
(*ii*) Subsidiary	
(*b*) Spillway	310 feet
(10) Cubic volume of the body of the dam	3,250,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	
(12) Specific gravity	
(*d*) Earthfill	
(13) Nature of protection and waterproofing of the upstream and downstream faces	The inner slope is protected by stone pitching 12 inches in thickness, on an 8-inch soiling of quarry spawls
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundations of the dam	By means of core-wall
(21) Hydraulic gradient for which the embankment is designed	
(22) Particular of the berm (if any) width and position	
(23) Position and form of the core-wall (or other means of securing water tightness)	As per cross section
(24) Batter (if any) of the core-wall	1 in 4
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	25·5 feet
(26) Method of keying core-wall or other wall in the underlying ground	Puddle trench
(27) Nature of material forming the core or other wall	Puddle

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  - (*a*) Crown waste
  - (*b*) Proprietory

(2) *Dislocation*
  - (*a*) Villages
  - (*b*) Families
  - (*c*) Population
  - (*d*) Roads
    - (*i*) Highways
    - (*ii*) District Roads
    - (*iii*) Village Roads
  - (*e*) Railway Lines
  - (*f*) Temples, mosques, *etc.*
  - (*g*) Graves, *etc.*
  - (*h*) Trees, gardens, pastures, houses, wells, *etc.*
  - (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Masonry weir 310 feet long designed for a maximum flood discharge of 7,300 cusecs
(2) Outlet works (3) Scouring works	Right and left bank sluices with iron shutters
(4) Inspection facilities	Sluice tower and tunnel under embankment accessible for inspection
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

- (3) Noteworthy occurrences and accidents
- (4) Operation of the dam
  - (*a*) Regulation
  - (*b*) Silting of the reservoir
    - (*i*) Total silt deposited
    - (*ii*) Rate of silting
    - (*iii*) Density of the silt deposited
    - (*iv*) Rate of advancement of delta
  - (*c*) Actual yield as against estimated
  - (*d*) Various measurements and observations
    - (*i*) Evaporation losses
    - (*ii*) Sweating below the dam
    - (*iii*) Temperature measurements
    - (*iv*) Seepage and regeneration
  - (*e*) Fish culture
  - (*f*) Anti malaria measures
- (5) Recreation facilities
- (6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

The scheme was first proposed by Mr. Hutton, Executive Engineer about the year 1902, and an estimate amounting to Rs. 2,94,341 was prepared by Mr. Morley, Executive Engineer. This estimate was revised by Captain H. de L. Pollard Lowsley, Executive Engineer in 1907 and reduced to Rs. 2,14,452

Both these estimates provided for a tank with a catchment area of 137 square miles and a capacity of 410 million cubic feet, the area that it was proposed to irrigate being to the south of the *nala* on which the tank was to be constructed. In June 1907 orders were issued to include in the commanded area the area on the right bank, and it was then decided to move the site of the tank 1½ miles lower down the *nala*, where the catchment area is 23·5 square miles

In 1908 Mr. B. N. Sarkar, Assistant Engineer, was employed on the preparation of the revised project, but his work was stopped in 1909 and the investigation was not resumed until May 1910, when Babu Labhsingh, Temporary Overseer, completed the project. The estimate prepared by him amounted to Rs. 5,10,574 for works only. It was submitted in June 1912 and was sanctioned by the Government of India in January 1913

During 1913 certain preliminary work was done under Mr. Ugrasinha Rao, Sub-Engineer, but the construction of the headworks was not actually commenced until early in 1914

(2) Personnel

1. Mr. W. H. Hallifax, Temporary Engineer
2. Rai Sahib S. N. Bhandari, Temporary Engineer
3. Capt. A. ff. Garrett, Royal Engineer
4. Mr. W. H. Todd, Executive Engineer
5. Mr. G. H. Forrest, Executive Engineer
6. Mr. N. C. Bhattacharya, Temporary Engineer
7. Mr. C. Q. Henriques, Executive Engineer

(3) Bibliography

Public Works Department Central Provinces " Completion report of the Bodalkasa Tank in Bhandara District. "

VI. 13. Wilson Dam

Masonry

I. GENERAL

(1) Height above the lowest river bed	270 feet
(2) Location	Ahmednagar district, Bombay State Pravara River
(3) Authority or owner	Bombay Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1910
(6) Year of completion	1926
(7) Capital cost	
(*a*) Estimated	(*a*) Rs. 37,99,291
(*b*) Actual	(*b*) Rs. 84,14,188
(8) Culturable area commanded by the project	198,807 acres
(9) Area irrigated	55,934 acres
(11) Means of access	The Ghoti Railway Station of the Great Indian Peninsular Railway is 21 miles from the dam. There is a good metalled road from the dam to the Railway Station. Ahmednagar town is also connected by metalled road which is 99 miles *via* Rajur, Akola, Sangamner, Loni Kolharand Rahuri

II. GEOPHYSICAL

(1) Area of catchment	47 square miles
(2) Nature of catchment	A remarkable ridge of rock almost entirely closes the valley, the river running in a deep narrow gorge with precipitory sides, bed and sides being formed of the best description of rock

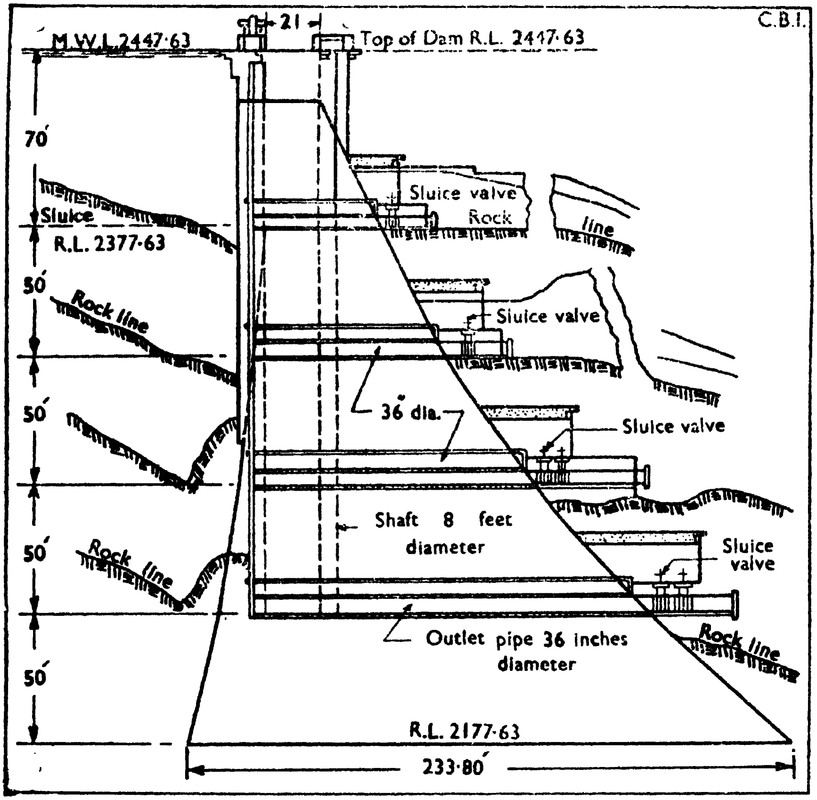
(3) Mean annual precipitation	
(*a*) Rainfall	(*a*) (*i*) 214·0 inches at the head of the lake (*ii*) 127·0 inches at the dam site
(4) Total average annual yield of the catchment	697,150 acre feet
(5) Climate	(*i*) Cold season, Dry and invigorating November to February (*ii*) Hot season, Hot and dry February to May (*iii*) Sultry oppressive weather May to June (*iv*) Temporate and pleasant, June onward
(6) Temperature conditions and variations	Maximum temperature 114°F Minimum temperature 40°F
(7) Rate of flow	
(*a*) Maximum	(*a*) 17,329 cusecs on 28th July 1927
(*b*) Minimum	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	Sweet and suitable for irrigation
(10) Geological features	
(*a*) of foundations	(*a*) Foundations on rock which is very sound
(*b*) of catchment area	(*b*) It is of ghat with heavy rainfall and of hard sheet rock and there is little or no absorption

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M.W.L.	2447·63
(*b*) F.R.L.	2443·33
(*c*) Area at M.W.L.	8 square miles
(*d*) Area at F.R.L.	
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	

(2) Capacity of the reservoir	
(*a*) Gross	
(*b*) Live	256,864 acre feet
(*c*) Flood storage	
(*d*) Carry-over	



Cross Section of Wilson Dam

(3) Maximum height above the lowest point of foundations	270 feet
(4) Height above the lowest river bed at dam	270 feet
(5) Height of the top of the dam above the crest of the spillway or weir	4·3 feet
(6) Maximum width at level of foundation	233·8 feet
(7) Width at top	21 feet
(8) Slopes	Radius of the curves for the height from the top of dam to bottom

(*a*) Upstream

(*b*) Downstream

Upstream face		Downstream face	
Height	Radius	Height	Radius
0 to 20	Straight	0 to 42	130
20 to 170	1,200	42 to 77	250
170 to 193	400	77 to 158·5	1,700
Below this	1,000	158·5 to 180	200
		180 to 200	540
		200 to 220	Straight

(9) Length at top of the dam	1,663 feet
(*a*) Non-over flow	
(*i*) Main	(*i*) 863 feet
(*ii*) Subsidiary	
(*b*) Spillway	(*b*) 800 feet.
(10) Cubic volume of the body of the dam	12,000,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Uncoursed rubble masonry in lime mortar. Hearting being done with excellent trap stone.
(12) Specific gravity	
(*a*) Masonry	(*a*) 2·4
(13) Nature of protection and waterproofing of the upstream and downstream faces	
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundations of the dam.	
(16) Contraction joints	
(17) Principal stresses in the masonry with a note of methods of calculations employed	It has been designed as a "gravity" section with maximum normal intensity of pressure of 185 lb per square inch and maximum intensity of 252 ℔ per square inch at R.L. 2,252·63.
(18) Maximum pressure on foundations	216·81 lbs per square inch
(19) Uplift pressure, calculated or measured	
(20) Measures adopted for preventing or counter-acting uplift pressures	

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*

- (*a*) Crown waste
- (*b*) Proprietory

(2) *Dislocation*

- (*a*) Villages
- (*b*) Families
- (*c*) Population
- (*d*) Roads
  - (*i*) Highways
  - (*ii*) District Roads
  - (*iii*) Village Roads
- (*e*) Railway Lines
- (*f*) Temples, mosques, etc.
- (*g*) Graves, etc.
- (*h*) Trees, gardens, pastures, houses, wells, etc.
- (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Crest of waste weir, R.L. 2,443·33. It is a broad crested weir 800 feet long and maximum discharging capacity 21,000 cusecs.
(2) Outlet works (3) Scouring works	There are four sets of pipes 36 inches diameter through the dam, two pipes in each set, 50 feet apart vertically and controlled at the water face by iron shutters, which are worked from the top of the dam and on the down-stream side by sluice valve enclosed in masonry chamber.
(4) Inspection facilities	
(5) Fish-pass	
(6) Means of dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	All work was completed mostly by manual labour excepting the use of crushers for breaking metal and chips, and mills for mixing mortar both worked on steam. Conveyance of materials was done by barges in the lake upstream of the Dam and by trolley lines, at other places. As the site of the Dam works was very steep, arrangements were made to shoot the mortar down to the work from both the Right and Left Banks.
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	Slight changes of alignment have been made to suit the foundation. The height was also raised from 260 to 270 feet during construction.
(3) Noteworthy occurrences and accidents	
(4) Operation of the dam	
(*a*) Regulation	Irrigation sluices worked upon by needle valves
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	
(*d*) Various measurements and observations	A square shaft eight feet by eight feet, has been constructed vertically through the highest part of the dam, in which by means of a plumb bob, any deflection in the verticality of the dam structure due to water pressure can be measured. No observations have yet been made in this respect.

(*i*) Evaporation losses

(*ii*) Sweating below the dam

(*iii*) Temperature measurements.

(*iv*) Seepage and regeneration

(*e*) Fish culture

(*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

The site for the dam was discovered in 1903 by Mr. Arthur Hill, Executive Engineer and the subsequent surveys were carried out by Mr. C. B. Pooley, Assistant Engineer, under the direction of Mr. H. O. B. Showbridge, Executive Engineer.

The construction was started in the year 1909-10 and in the first two seasons rupees 2·8 lakhs were spent on preliminary work preparing foundations etc. In 1911-12 masonry work was started and completed in 1925-26.

In the year 1938-39 it was proposed to raise the crest of the weir by 6·4 feet, and the section was designed but only 4·5 feet raising was carried out during the year. In the year 1940-41, its raising was completed but to the height of 5·70 feet above the original crest and not to the height of 6·4 feet proposed.

In view of the scouring action due to wave wash the work of protecting the bank near the first class Inspection Bungalow by stone pitching was carried out in 1940.

(2) Personnel

Executive Engineers

(*i*) H. O. B. Showbridge, Esqr., M.I.C.E.

(*ii*) N. B., Baxter, Esqr.

(*iii*) S. C. Mould, Esqr., B.A.

(*iv*) T. A. Andrew, Esqr., B.Sc.

(*v*) W. H. E. Garrod, Esqr., A.M.I.C.E.

(*vi*) A. B. Timms, Esqr.

(3) Bibliography

(*i*) Wilson Dam and the Pravara canals system 1940-41 (typed note).

(*ii*) Stability diagram and calculations of the Wilson Dam (typed note).

(*iii*) History sheet for 1938-39 of Head Works Bombay (typed note).

VI. 14. Royenpally Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	54·5 feet
(2) Location	Medak District Hyedrabad State (Pushpal Stream)
(3) Authority or owner	The Hyderabad Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1922
(6) Year of completion	1926
(7) Capital cost	
(*a*) Estimated	Rs. 2,83,000
(*b*) Actual	Rs. 3,17,531
(8) Culturable area commanded by the project	
(9) Area irrigated	1,250 acres
(11) Means of access	It is 5 miles from Medak town and 7 miles from Aknapet Railway Station on Hyderabad Manmad line.

II. GEOPHYSICAL

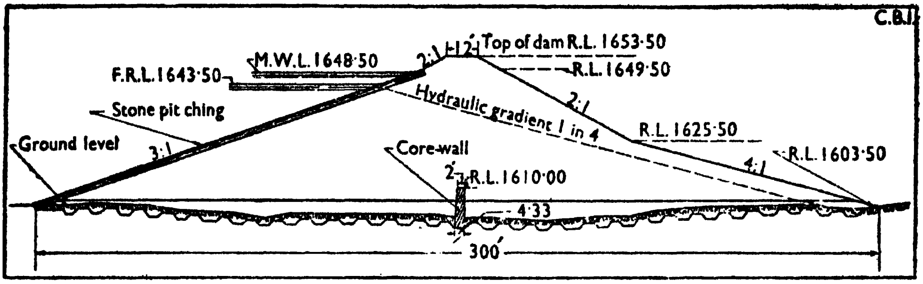
(1) Area of catchment	34 square miles
(2) Nature of catchment	
(3) Mean annual precipitation	
(*a*) Rainfall	35·69 inches
4) Total average annual yield of the catchment	5,930 acre feet
(5) Climate	Tropical
(6) Temperature conditions and variations	Maximum temperature 106°F Minimum temperature 52°F.
(7) Rate of Flow	
(*a*) Maximum	16,600 cusecs
(*b*) Minimum	

(8) Detritus charge of the stream	The country being plain and intercepted by a number of tanks, there is very little silt charge in the water.
(9) Character (chemical) of the water stored in the reservoir	Sweet and clear
(10) Geological features	
(*a*) of foundations	Granite
(*b*) of catchment area	

III. TECHNICAL

A. STATISTICAL

1. Reservoir Data	
(*a*) M. W. L.	R. L. 1648·50
(*b*) F. R. L.	R. L. 1643·50
(*c*) Area at M. W. L.	0·73 square miles
(*d*) Area at F. R. L.	
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
2. Capacity of the reservoir	
(*a*) Gross	5,170 acre feet
(*b*) Live	4,560 acre feet
(*c*) Flood storage	
(*d*) Carry over	



Cross Section of Royenpally Dam

(3) Maximum height above the lowest point of foundations	57·5 feet
(4) Height above the lowest river bed at dam	54·5 feet
(5) Height of the top of the dam above the crest of the spillway or weir	10 feet
(6) Maximum width at level of foundation	300 feet

(7) Width at top	1·8 to 12 feet
(8) Slopes	
(a) Upstream (b) Downstream	As per cross section
(9) Length at top of the dam	4,100 feet
(a) Non overflow—	
(i) Main	3,590 feet
(ii) Subsidiary	
(b) Spillway or waste weir	510 feet
(10) Cubic volume of the body of the dam	

B. OTHERS

(11) Material of which the dam is constructed	*Chowka* and *Moorum* soil for *bunds* Laminated stone for revetment and masonry work
(13) Nature of protection and water proofing of the upstream and downstream faces	
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundations of the dam	By means of core-wall and laminated stone masonry
(21) Hydraulic gradient for which the embankment is designed	1 in 4
(22) Particular of the berm (if any) width and position	
(23) Position and form of the core-wall (or other means of securing water tightness)	Masonry core-wall in the river portion only from chainage 15·20 to 18·0
(24) Batter (if any) of the cor wall	1 in 8
(25) Maximum depth below ground surface of corewall or other means of securing water tightness	3 feet
(26) Method of keying core-wall or other wall in the underlying ground	Benching foundations
(27) Nature of material forming the core or other wall	Laminated course stone masonry in *surkhi* Mortar

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*

(a) Crown waste

(b) Proprietory

(a) Villages
(b) Families
(c) Population
(d) Roads
  (i) Highways
  (ii) District Roads
  (iii) Village Roads
(e) Railway Lines
(f) Temples, mosques, etc.
(g) Graves, etc.
(h) Trees, gardens, pastures, houses, wells, etc.
(i) Bridges

(3) Compensation paid under each category of item (2)
(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplusing works	A free overfall weir 510 feet in length is built at left flank
(2) Outlet works	High bund sluice of 3 vents each three feet by four feet and low level sluices of three pipes each 8 inches diameter and at 5 feet intervals
(3) Scouring works	
(4) Inspection facilities	
(5) Fish pass	
(6) Means for dissipating energy below the spillway	

VII. SUPPLEMENTARY INFORMATION

(1) Constructional features	The earth was placed in 9 inch layers and consolidated with watering and by steam road roller.
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurrences and accidents	
(4) Operation of the dam	

- (*a*) Regulation
- (*b*) Silting of the reservoir
  - (*i*) Total silt deposited
  - (*ii*) Rate of silting
  - (*iii*) Density of the silt deposited
  - (*iv*) Rate of advancement of delta
- (*c*) Actual yield as against estimated
- (*d*) Various measurements and observations
  - (*i*) Evaporation losses
  - (*ii*) Sweating below the dam
  - (*iii*) Temperature measurements
  - (*iv*) Seepage and regeneration
- (*e*) Fish Culture
- (*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	
(2) Personnel	Nawab Ali Nawaz Jang Bahadur, F. C. H., Chief Engineer.
(3) Bibliography	

VI. 15. Bori Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	54·7 feet
(2) Location	Chhindwara District, **Madhya** Pradesh, (Godum *Nala*)
(3) Authority or Owner	Madhya Pradesh Government
(4) Purpose—Main and Subsidiary	Irrigation
(5) Year of commencement	1923
(6) Year of completion	1927
(7) Capital cost	
(8) (*a*) Estimated	Rs. 9,40,670 (Project)
(*b*) Actual	Rs. 10,67,262
(9) Culturable area commanded by the project	13,860 acres
(10) Area Irrigated	Kharif—6,272 acres
	Cane—40 acres
(12) Means of access	It is accessible by road from Seoni Railway Station, Bengal Nagpur Railway and is located in M. 11F4 & 1 mile off on Seoni Balaghat Road

II. GEOPHYSICAL

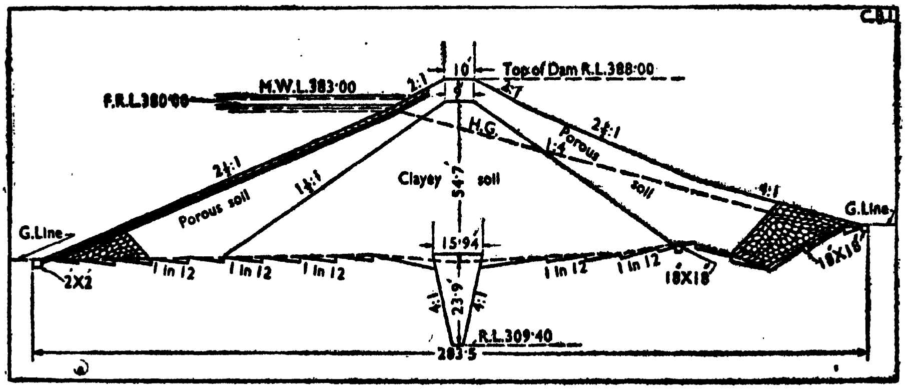
(1) Area of Catchment	20·6 square miles
(2) Nature of catchment	Steep hills covered with thick jungle
(3) Mean annual precipitation	
(*a*) Rainfall	42·85 inches (Adopted for project)
(4) Total average annual yield of the catchment	21,625 acre feet.
(5) Climate	Hot
(6) Temperature conditions & variation	
(7) Rate of flow	

(*a*) Maximum	11,649 cusecs
(*b*) Minimum	
(8) Detritus charge of the stream	Silt and sand
(9) Character (chemical) of the water stored in the reservoir	It is clear for 8 months and silt laden for 4 months.
(10) Geological features	
(*a*) Of foundations	Soft rock 10 feet to 12 feet below *nala* bed
(*b*) Of catchment area	The catchment area has black soil with few patches of mixed soil ofother kinds.

III. TECHNICAL

A STATISTICAL

(1) Reservoir Data	
(*a*) M. W. L.	383·00
(*b*) F. R. L.	380·00
(*c*) Area at M. W. L.	1·187 square miles
(*d*) Area at F. R. L.	1·10 square miles
(*e*) Maximum length	6 miles
(*f*) Maximum width	4½ miles
(*g*) Length of Periphery	18½ miles
(2) Capacity of the reservoir	
(*a*) Gross	9,093·2 acre feet
(*b*) Live	8,092 acre feet
(*c*) Flood storage	
(*d*) Carry over	2,697 acre feet



Cross Section of Bori Dam

(3) Maximum height above the lowest point of foundations	78·6 feet
(4) Height above the lowest river bed at dam	54·7 feet
(5) Height of the top of the dam above the crest of the spillway or weir	8·0 feet
(6) Maximum width at level of foundation	283·5 feet
(7) Width of Top	10·0 feet
(8) Slopes	
(*a*) Upstream	2 : 1 and 2½ : 1
(*b*) Down Stream	2 : 1, 2½ to 1 and 4 to 1
(9) Length at top of the dam	6,248 feet
(*a*) Non overflow	
(*i*) Main	5,828 feet
(*ii*) Subsidiary	
(*b*) Spillway	420 feet
(10) Cubic volume of the body of the dam	8,200,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Hearting of clayey soil and casing of porous soil
(12) Specific gravity	
(13) Nature of protection and water proofing of the upstream and downstream faces	Upstream face pitched and down stream face grassed
(14) Provision for dealing with seepage and drainage water	Seepage drains provided
(15) Means of securing water tightness of the foundations of the dam	By means of Puddle core-wall
(21) Hydraulic gradient for which the embankment is designed	1 in 4
(22) Particular of the berm (if any) width and position	
(23) Position and form of the core wall or other means of securing water tightness	As per cross section
(24) Batter (if any) of the core-wall	4 in 1
(25) Maximum depth below ground surface of core wall or other means of securing water tightness	23·9 feet

(26) Method of keying core wall or other wall in the under-lying ground	Puddle trench filling carried upto 2 feet above ground level and keyed into selected earth hearting
(27) Nature of material forming the core or other wall	Puddle topped with hearting of good earth

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) Land submerged	
(*a*) Crown waste	
(*b*) Proprietory	745·59 acres.
(2) Dislocation	
(*a*) Villages	
(*b*) Families	
(*c*) Population	
(*d*) Roads	
(*i*) Highways	
(*ii*) District Roads	
(*iii*) Village Roads	
(*e*) Railway lines	
(*f*) Temples, mosques, etc.	
(*g*) Graves, etc.	
(*h*) Trees, gardens, pastures, houses, wells, etc.	A few trees were submerged along with cultivated land.
(*i*) Bridges	
(3) Compensation paid under each category of item (2)	There is no record available at present but it is known that due compensation was paid.
(4) Method of compensating for land of dispossessed landholders	In cash

V. AUXILIARY WORKS

(1) Surplussing Works	Waste weir is a submerged fall of 3·2 feet and 420 feet long. Its abnormal discharging capacity is 11,649 cusecs.
(2) Outlet works	Sluice gate of iron shutter
(3) Scouring works	
(4) Inspection facilities	
(5) Fish pass	
(6) Means for dissipating energy below the spillway	There are series of falls in the spillway to prevent scour.

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	The dam is made of earth pitching is carried upto F. R. L. and rests against a toe wall. Boulders toes have been provided to facilitate exit of any seepage water as also to prevent drainage to earth work by back water of main Nala during floods.
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurences and accidents	On August 20, 1926 it was observed that in a length of 400 feet from R. D. 3,600 to R. D. 4,000 the downstream slope was in motion the portion just beneath the crest of the embankment setting down rapidly, while the toe was being pushed upwards and outwards. The slope was assuming an irregular wave form with much cracking and fissuring. On the same day the crest had sunk about 10 feet and the toe pushed forward about 25 feet. Emergent arrangements were immediately made.
(4) Operation of the dam	
(*a*) Regulation	The sluice gear is hand operated, and the height of opening is so regulated as to give a definite depth of water in the main channel corresponding to the discharge required.
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	311·4 acre feet
(*ii*) Rate of silting	22·3 acre feet
(*iii*) Density of the silt deposited	101·5 lb. per cubic foot
(*iv*) Rate of advancement of Delta	
(*c*) Actual yield as against estimated	Actual average yield 21,625 acre feet against estimated yield of 18,542 acre feet
(*d*) Various measurements and observations	
(*i*) Evaporation and Losses	83·4 million cubic feet per annum (both evaporated and absorption)
(*ii*) Sweating blow the dam	

(*iii*) Temperature measurement
(*iv*) Seepage and regeneration
(*e*) Fish culture
(*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilization of the dam

A careful watch has to be exercised during construction to comply with the requirements of sound construction. Such irrigation bunds have a feature in this country which is not unfrequently subject to famine.

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

The scheme was first investigated at the request of the Commissioner, Jubbulpore Division to provide irrigation for the Burghat Tract of the Chhindwara District and preliminary estimate amounting to Rs. 3,45,392 for the construction of a tank of 3·31 million cubic feet capacity designed to irrigate 5,000 acres of *kharif* was submitted in May 1919. This scheme was not approved but orders were given to prepare an estimate for the work in the final stage, as a major work, to irrigate 9,000 acres of rice. An estimate for the work on these lines amounting to Rs. 4,09,082 for works only and to Rs. 7,38,715 including all charges was submitted in March 1923 and was sanctioned by the local Government in their letter No. C-263-67-W.I, dated the 2nd June 1293. Orders were given that arrangements should be made to commence construction of the work at once but that a revised estimate should be prepared providing for a tank with F. R. L. three feet lower *i.e.*, at R. L. 377 suitable for the irrigation of 8,000 acres of rice.

Work was started before the end of the year 1923. The revised estimate for the work was sanctioned by the local Government in their letter No. 25-B-W. 1., dated 4th April 1925. The revised estimate provided for a tank with a catchment area of 19·6 square miles and an irrigating capacity of 352 million cubic feet and the area to be irrigated was fixed at 8,000 acres of rice.

In July 1925, when the work was to start, it was considered that saving could be effected by altering the downstream slope of the embankment in accordance with the revised type section that had recently been approved by the local Government. The revised abstract estimate amounting to Rs. 6,00,372 for works only and Rs. 9,40,670 including all charges was submitted in August 1925 and was sanctioned by the local Government in their letter No. 25-F. W. 1., dated 11th September 1925.

(2) Personnel

The staff of the Madhya Pradesh P.W.D. executed the work departmentally and consisted of an Executive Engineer an Assistant Engineer and couple of overseers and other subordinate staff.

(*i*) Mr. W. C. Rose, Executive Engineer.

(*ii*) Shri B. B. Gupta, Assistant Engineer.

(*iii*) Shri J. S. Duacan, Assistant Engineer.

(3) Bibliography

Public Works Department—Central Provinces " completion Report of Bori Tank in the Chhindwara District.

VI. 16. Nizam Sagar Dam

(Masonry)

I. GENERAL

(1) Height above the lowest river bed	115·5 feet.
(2) Location	Nizammabad District, Hyderabad, Deccan. (Manjira river, Godavari Basin)
(3) Authority or owner	Hyderabad Government
(4) Purpose Main and subsidiary	Irrigation
(5) Year of commencement	October 1923
(6) Year of completion	October 1931
(7) Capital cost	
(*a*) Estimated	Rs. 1,56,90,000
(*b*) Actual	Rs. 2,18,48,000
(8) Culturable area commanded by the project.	5,36,537 acres
(9) Area irrigated	2,75,000 acres
(11) Means of access	It is situated 41 miles from Akhunapet Station on the Secunderabad Manmad line and is also accessible by road from Hyderabad —98 miles distant.

II. GEOPHYSICAL

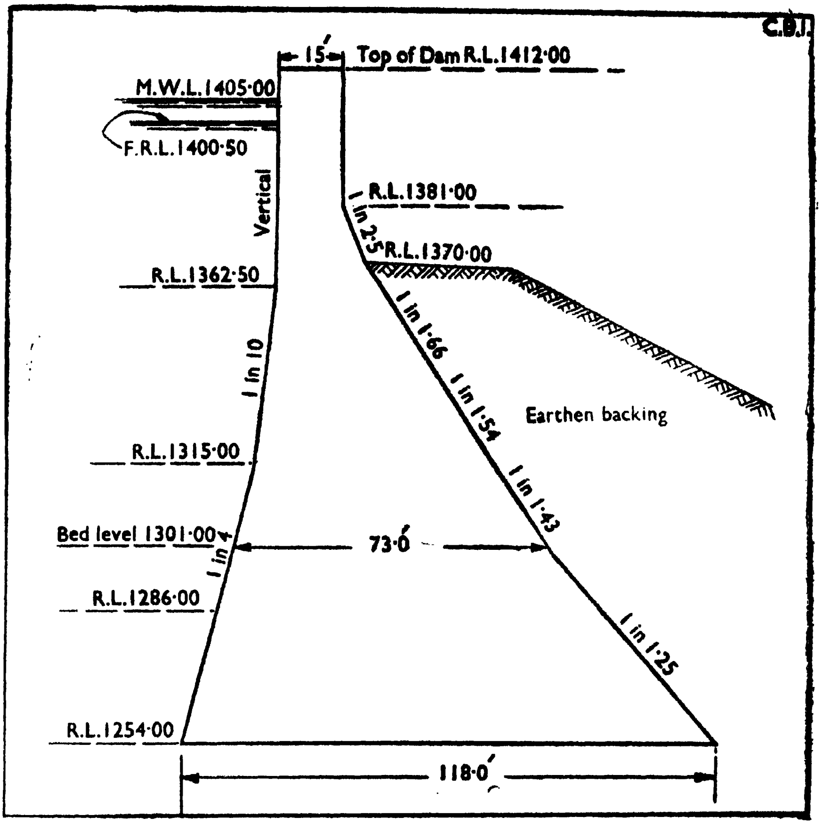
(1) Area of catchment	8,376 square miles
(2) Nature of catchment	
(3) Mean annual precipitation	
(*a*) Rainfall	31·9 inches
(4) Total Average annual yield of the catchment	2,610,480 acre feet
(5) Climate	Tropical

(6) Temperature conditions and variations.	Maximum temperature 106°F. Minimum temperature 51°F.
(7) Rate of Flow	
(*a*) Maximum	215,264 cusecs
(*b*) Minimum	
(8) Detritus charge of the stream	The river is comparatively free from silt. During monsoon period, it carries silt in a very nominal ratio *i.e.*, one part of silt in 497 parts of water by volumes
(9) Character (chemical) of the water stored in the reservoir	Soft water, suitable for domestic and irrigation purposes
(10) Geological features	
(*a*) of foundations	Granite with trap dykes
(*b*) of catchment area	Granite and trap

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M. W. L.	R. L. 1405·00
(*b*) F. R. L.	R. L. 1400·50
(*c*) Area at M. W. L.	56·51 square miles
(*d*) Area at F. R. L.	47·8 square miles
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	682,050 acre feet
(*b*) Live	587,660 acre feet
(*c*) Flood storage	
(*d*) Carry over	
(3) Maximum height above the lowest point of foundations	157·5 feet
(4) Height above the lowest river bed at dam	115·5 feet
(5) Height of the top of the dam above the crest of the spillway or weir	11·5 feet above the crest of the weir and 27 feet above the sill of the automatic gates
(6) Maximum width at level of foundation	118 feet



Cross section of the Nizamsagar Dam

(7) Width at top	15 feet
(8) Slopes (*a*) Upstream (*b*) Downstream	As per cross section
(9) Length at top of the dam	10,350 feet
(*a*) Non overflow	
(*i*) Main	
(*ii*) Subsidiary	
(*b*) Spillway	3,120 feet
(10) Cubic volume of the body of the dam	30,650,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed.	Uncoursed rubble stone masonr

(12) Specific gravity	
(*a*) Masonry	2·25
(13) Nature of protection and water proofing of the upstream and down-stream faces	
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundations of the dam	
(16) Contraction joints	
(17) Principal stresses in the masonry with a note of methods of calculations employed	It is a solid gravity dam of rubble masonry with a specific gravity of 2·25. The stresses employed for designing purposes are according to Mr. M. Bouviar's and Dr. Unwin's Theories.
(18) Maximum pressure on foundations	Maximum stress as per Dr. Unwin's method is 10·67 tons per square foot and according to Mr. M. Bouviar's Methods it is 8·48 tons per square foot.
(19) Uplift pressure, calculated or measured	As the dam rests on impervious rock no allowance for uplift pressure has been made.
(20) Measures adopted for preventing or counteracting uplift pressures	

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*	
(*a*) Crown waste	
(*b*) Proprietory	
(2) *Dislocation*	
(*a*) Villages	40
(*b*) Families	
(*c*) Population	
(*d*) Roads	
(*i*) Highways	
(*ii*) District Roads	
(*iii*) Village Roads	
(*e*) Railway Lines	
(*f*) Temples, mosques, etc.	
(*g*) Graves, etc.	

(*h*) Trees, gardens, pastures, houses, wells, etc.	
(*i*) Bridges	
(3) Compensation paid under each category of item (2)	Rs. 34,31,000 (total)
(4) Method of compensating for land of dispossessed landholders	Rs. 34,31,000 (Cash)

V. AUXILIARY WORKS

1. Surplussing works	Two waste weirs No. 1 and No. 2 are 800 feet and 1,200 feet in length respectively at the extreme left flanks. In addition to these a major portion of water is disposed of through 28 automatic gates, 16 on left flank and 12 on the right flank of the main dam. Size of each gate is 40 feet by 15-1/2 feet.
2. Outlet works	One outlet sluice of 11 vents each 8 feet by 10½ feet
3. Scouring works	Scouring sluices of 9 gates each 8 feet by 15 feet and also to dispose of a certain quantity of flood water
4. Inspection facilities	
5. Fish pass	
6. Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

1. Constructional features	Its construction is considered of very huge magnitude and it is mostly built with coursed rubble masonry as face work and uncoursed rubble masonry for hearting. Coping arch work, sil stones are of finely dressed granite. The different portions of the dam extended over a distance of 4 miles, the weirs and composite dam portions were done by contract agency. The main dam being the costliest item of the whole scheme the work was done departmentally.

	A programme of operations involving a period of 8 years was drawn up on the basis of out turn of 4 million cubic feet of masonry per annum with a maximum of 6 million cubic feet. Most of the excavation of foundations was completed by the end of first 2 years and masonry was started in the 1st year itself. Both the arms of the river were alternately used for temporary flood escapes during monsoons. With the exception of a gap of 800 feet in the middle the river was blocked finally by the beginning of 6th year for errection and completion of flood gates. The main dam was brought well above the maximum water level by the end of 7th year for finishing up of the work involving construction of road way, parapets, etc. By the end of 8th year the work was completed and the head works of the Reservoir were set in operation.
	Materials used for construction are stone available close to the dam, sand within an average distance of 4 miles, *surkhi* earth available within 2 miles of the dam site and Lime stone brought from an average distance of 14 miles.
	Fuel Wood was available in abundant from the forest and specially from the submerged area.
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	The dam was designed as a solid gravity dam of rubble masonry in *surkhi* mortar and the only important modification effected while carrying out the work was that the top width of main dam was increased from 11 to 15 feet with a parapet wall 3 feet high on either side supported on corbels. The top of the dam has a clear road way of 14 feet. The free board was decreased from 9 feet to 7 feet only. The work was done by

	manual labour and mechanical power was resorted to partly for trasportation of materials and mortar grinding
(3) Noteworthy occurrences and accidents	In the duration of its construction period there had been only 18 accidents as serious and 15 minor-ones ; Out of these only 10 accidents were fatal
(4) Operation of the dam	
(*a*) Regulation	
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimaed	
(*d*) Various measurements and observations	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	Locally available material and labour greatly effects on the cost towards cheapness and lessens the period limit of the construction

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	The river Manjira a tributary of the Godavari, is the largest of those rivers that have their rise and entire course within the Hyderabad State. Till the year 1916 little use had been made of the Manjira for the purpose of Irrigation. It carried away every year a sufficient

quantity of water, which if utilised could have irrigated nearly 600,000 acres or about a thousand square miles of rice crop. The Mahboob Nakar being the right bank channel from the anicut across the river at Ghanpur was the only work on the river and utilised about 2 percent of this water.

The then Chief Engineer and Secretary, P. W. D. Hyderabad State Government conceived the idea that in order to make the most beneficial utilization of the Manjira waters, they must be stored in large reservoirs and used not only for irrigation but also for the production of electricity. The irrigation scheme has come to realisation, from the Nizamsagar Project, which has raised the percentage of the utility of river from 2 percent to 50 percent.

The canal works were started simultaneously with the reservoir and were completed before the end of 1933.

It is one of the largest gravity dams in the world.

(2) Personnel

Nawab Ali Nawaz Jung Bahadur F. C. H. Chief Engineer, Mr. C. C. Paul was the Executive Engineer incharge of construction.

(3) Bibliography

(1) History of Nizamsagar Project completed by Dr. S. P. Raju.

(2) Nizamsagar Project—A Souvenir

CHAPTER VII

MAHANADI BASIN

VII. 1. Tandula Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	82·1 feet
(2) Location	Tandula and Sukha *nalas*, Drug District Madhya Pradesh
(3) Authority or owner	Madhya Pradesh Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1910
(6) Year of completion	1921
(7) Capital cost	
(*a*) Estimated	(*a*) Rs. 36,19,942
(*b*) Actual	(*b*) Rs. 33,86,600 (works only)
(8) Culturable area commanded by the project	608,516 acres
(9) Area irrigated	150,524 acres
(10) Means of access	It is accessible from Dhamtri Railway Station by road, situated about 25 miles towards East of the dam site It is also accessible from Drug Railway Station, at a distance of about 37 miles North of the dam site

II. GEOPHYSICAL

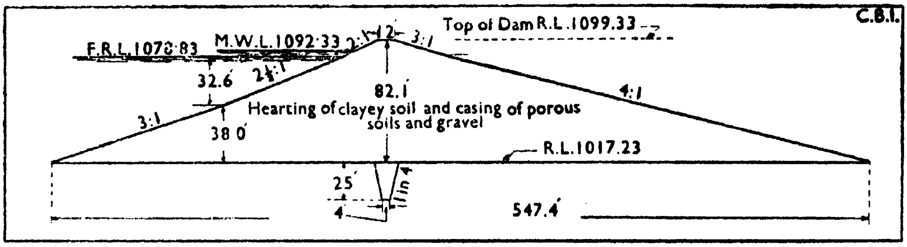
(1) Area of catchment	319·4 square miles
(2) Nature of catchment	Area covered with Jungle and Slopes 1 in 300 to 1 in 1,000
(3) Mean annual precipitation	
(*a*) Raifall	54·99 inches
(4) Total average annual yield of the catchment	339,073 acre feet
(5) Climate	5 months hot and dry, 4 months hot and humid and temperate for 3 months

(6) Temperature conditions and variations	
(7) Rate of Flow	
(*a*) Maximum	47,500 cusecs
(*b*) Minimum	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	It is clear for 8 months and silt laden for 4 months
(10) Geological features	
(*a*) of foundations	Mostly matasi underlain by moorum and laterite
(*b*) of catchment area	Moorumy
(11) Earthquake (Zone and intensities)	

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M.W.L.	R.L. 1092·33
(*b*) F. R. L.	R. L. 1087·83
(*c*) Area at M. W. L.	
(*d*) Area at F. R. L.	16·93 square miles
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	
(*b*) Live	222,950 acre feet
(*c*) Flood storage	
(*d*) Carry-over	



Cross Section of Tandula Dam

(3) Maximum height above the lowest point of foundations	107·10 feet
(4) Height above the lowest river bed at dam	82·1 feet
(5) Height of the top of the dam above the crest of the spillway or weir.	11·5 feet
(6) Maximum width at level of foundation.	548·4 as per sketch
(7) Width at top	12·0 feet
(8) Slopes	
(*a*) Upstream	3 : 1, 2½ : 1, 2¼ : 1 and 2 : 1
(*b*) Downstream	4 : 1 and 3 : 1
(9) Length at top of the dam	14,500 feet
(*a*) Non-overflow	
(*i*) Main	12,028 feet
(*b*) Spillway	2,472 feet
(10) Cubic volume of the body of the dam	92,240,740 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Hearting of clayey soil and casing of porous soils and gravel
(12) Specific gravity	
(*a*) Earthfill	
(13) Nature of protection and waterproofing of the upstream and downstream faces	Dry stone pitching on the upstream slope
(14) Provision for dealing with seepage and drainage water	Seepage drains have been provided under both the Sukha and Tandula embankments.
(15) Means of securing water tightness of the foundations of the dam	By means of puddle core-wall
(21) Hydraulic gradient for which the embankment is designed	
(22) Particular of the berm (if any) width and position	
(23) Position and form of the core-wall (or other means of securing water tightness)	As per sketch
(24) Batter (if any) of the core-wall	1 in 4

(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	25 feet
(26) Method of keying core-wall or other wall in the underlying ground	Puddle trench
(27) Nature of material forming the core or other wall	Puddle

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory
(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads
    (*i*) Highways
    (*ii*) District Roads
    (*iii*) Village Roads
  (*e*) Railway Lines
  (*f*) Temples, mosques, etc.
  (*g*) Graves, etc.
  (*h*) Trees, gardens, pastures, Houses, wells, etc.
  (*i*) Bridges
(3) Compensation paid under each category of item (2)
(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Waste weir, 2,472 feet long with discharging capacity 122,000 cusecs
(2) Outlet works	There are three vents each 8 feet × 8 feet, and double control is provided, the inner gates are of the stoney pattern and the outer gates of the penstock type with secondary vents
(3) Scouring works	
(4) Inspection facilities	Sluice tower and tunnel under embankment accessible for inspection

(5) Fish-pass	
(6) Means for dissipating energy below the spillway	The spillway is mostly rock though stratified with layers of *moorum* between the strata and has so far stood well. No means for dissipating energy below the spillway are found necessary

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurrences and accidents	The first slip on the Sukha embankment occurred on the 27th October 1918, and movement continued until the 2nd November and settled vertically to a depth of 12 feet and the upstream face had assumed a slope of 3 in 1. Cause of the failure was realized subsequently, viz. the use of material which was not suitable for construction. The slip was repaired before the rains of 1919. There occurred a second slip on 13th August 1920 on the inner slope of the embankment and movement continued until 29th August and assumed a slope of 3 in 1. The slip was repaired before rains in 1921
(4) Operation of the dam	
(*a*) Regulation	
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	1172·6 acre feet
(*ii*) Rate of silting	53·26 acre feet (annually)
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	14,769·6 million cubic feet against 17,233 million cubic feet estimated
(*d*) Various measurements and observations	

- (*i*) Evaporation losses
- (*ii*) Sweating below the dam
- (*iii*) Temperature measurements
- (*iv*) Seepage and regeneration

(*e*) Fish culture

(*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction & utilisation of the dam	From the construction of the Sukha embankment, it was experienced that it was not safe to construct the upstream face of the dam to a steep slope as 2¼ in 1. It is used for irrigation purpose.

IX. BIBLIOGRAPHY

(1) Historical	Prior to the issue of the report of the Irrigation Commission, work had been commenced on certain comparatively small tanks in the Raipur District which at that time included the Drug District. No large works had been investigated. In accordance with the recommendations of the Commission, in paragraph 336 of their report, the feasibility of irrigation in the tract between the Karun and the Sheonath rivers by means of small canals from the Karun and the Sukha rivers was examined, but it was found that the supply available in these rivers was insufficient for the reliable irrigation of any considerable area. Investigation was then made, with a view to find a suitable site for a storage work in the upper reaches of the Sukha river, but no suitable site could be found and it was proposed to abandon the scheme. However, in March 1905, Mr. G. M. Harriott, Superintending Engineer, Irrigation Circle, examined the possibilities of the site near Balod on which the Sukha and Tandula reservoirs have since been constructed and decided that it was sufficiently favourable to warrant further investigation.

The investigation was completed before the rains of 1907 and the Tandula Project was submitted by Captain A. ff. Garrett, R. E., in December of that year. It had been prepared in accordance with the orders of the Government of India contained in their letters Nos. 744-I, dated the 30th May 1907 and 938-I, dated the 21st June 1907. It was sanctioned by the Government of India in their letter No. 526-I, dated the 12th May 1909, and work was commenced in July 1910.

(2) Personnel

1. Mr. G. M. Harriott, Superintending Engineer, Irrigation Circle.
2. Captain A. ff. Garrett, Royal Engineer.
3. Mr. G. L. Thomson, Executive Engineer.
4. Mr. G. H. Forrest, Executive Engineer.
5. Mr. E. L. Glass, Executive Engineer.
6. Mr. G. A. Phear, Executive Engineer.

(3) Bibliography

Public Works Department, Central Provinces, " Completion report of the Tandula Canal Project in the Drug District".

VII. 2. Maramsilli Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	83·7 feet
(2) Location	Raipur district, Madhya Pradesh (Silauria Nala)
(3) Authority or owner	Madhya Pradesh Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1914
(6) Year of completion	1923
(7) Capital cost	
(a) Estimated	(a) Rs. 28,77,078
(b) Actual	(b) Rs. 31,17,537 (Works only)
(8) Culturable area commanded by the project	801,926 acres Under the Mahanadi canal system of which Maramsilli Dam tank is a feeder tank.
(9) Area irrigated	200,000
(11) Means of access	It is about 16 miles above the head-works of Mahanadi canal project, and there is a road from Dhamtari Railway Station to the head works and the same leads to Maramsilli reservoir. Dhamtari Railway Station is the last station close to head works on the line coming from Raipur railway station.

II. GEOPHYSICAL

(1) Area of catchment	187 square miles
(2) Nature of catchment	
(3) Mean annual precipitation	
(a) Rainfall	47·52 inches
(b) Snow	

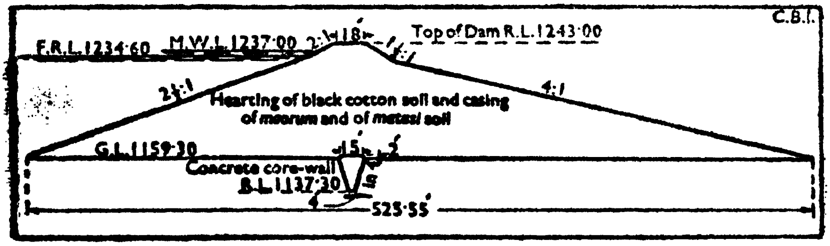
(4) Total average annual yield of the catchment	186,363 acre feet
(5) Climate	Hot with extreme variation in humidity
(6) Temperature conditions and variations	Hot with extreme variation in humidity
(7) Rate of flow	
(*a*) Maximum	(*a*) Estimated at 70,700 cusecs
(*b*) Minimum	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	It is clear for 8 months and silt laden for 4 months
(10) Geological features (*a*) of foundations	The dam is aligned roughly South-West to North-West abutment being the foot of an isolated hill of geneissose granite capped by the Cuddapah sandstone while the North-West end of the dam abuts against a spur of geneissose granite capped by the same sandstone. The dam itself stands on foundations of decomposed granite
(*b*) of catchment area	(*b*) Vindhya and granite

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M.W.L.	(*a*) R.L. 1237·00
(*b*) F. R. L.	(*b*) R. L. 1234·60
(*c*) Area at M.W.L.	(*c*) 10·2 square miles
(*d*) Area at F.R.L.	(*d*) 9·8 square miles
(*e*) Maximum length	(*e*) 8·75 miles
(*f*) Maximum width	(*f*) 3·5 miles.
(*g*) Length of periphery	(*g*) 22 miles

(2) Capacity of the reservoir	
(*a*) Gross	(*a*) 134,045 acre feet
(*b*) Live	(*b*) 131,267 acre feet
(*c*) Flood storage	
(*d*) Carry-over	



Cross Section of Maramsilli Dam

(3) Maximum height above the lowest point of foundations	105·7 feet
(4) Height above the lowest river bed at dam	83·7 feet
(5) Height of the top of the dam above the crest of the spillway or weir	7·5 feet from the highest crest level of syphons
(6) Maximum width at level of foundation	525·55 feet
(7) Width of top	18 feet
(8) Slopes	
(*a*) Upstream	(*a*) 2 : 1 and 2½ : 1
(*b*) Downstream	(*b*) 1½ : 1 and 4 : 1
(9) Length at top of the dam	8,500 feet
(*a*) Non-overflow	
(*i*) Main	
(*ii*) Subsidiary	
(*b*) Spillway	
(10) Cubic volume of the body of the dam	44,441,008 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Earthen dam, with hearting of black cotton soil and casing admixture of matasi and *moorum*
(12) Specific gravity	
(*a*) Earthfill	

(13) Nature of protection and water proofing of the upstream and downstream faces	Protected by stone pitching on the upstream side
(14) Provision for dealing with seepage and drainage water	Seepage drains provided
(15) Means of securing water tightness of the foundations of the dam	By means of concrete core-wall
(21) Hydraulic gradient for which the embankment is designed	1 in 4
(22) Particular of the berm (if any) width and position	
(23) Position and form of the core-wall (or other means of securing water tightness)	As per sketch
(24) Batter (if any) of the core-wall	1 in 4
(25) Maximum depth below ground surface of core wall or other means of securing water thigtness	22 feet
(26) Method of keying core-wall or other wall in the underlying ground	Trench core-wall
(27) Nature of material forming the core or other wall	Lime concrete

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
- (*a*) Crown waste
- (*b*) Proprietory

(2) *Dislocation*
- (*a*) Villages
- (*b*) Families
- (*c*) Population
- (*d*) Roads
  - (*i*) Highways
  - (*ii*) District Roads
  - (*iii*) Village Roads
- (*e*) Railway Lines
- (*f*) Temples, mosques, etc.
- (*g*) Graves, etc.
- (*h*) Trees, gardens, pastures, Houses, wells, etc.
- (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders	

V. AUXILIARY WORKS

(1) Surplusing works	A battery of 34 automatic syphons discharging capacity 40,000 cusecs and two breaching sections in the ridge on the right flank of the reservoir.
(2) Outlet works	3 Vents of 10 feet X 8·9 feet with double central gates
(3) Scouring works	
(4) Inspection facilities	Sluice tower and tunnel under embankment accessible for inspection.
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	Syphon spillway substituted for ordinary waste weir
(3) Noteworthy occurrences and accidents	
(4) Operation of the dam	
(*a*) Regulation	
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	519·5 acre feet
(*ii*) Rate of silting	25 acre feet annually
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	8,118 million cubic feet against 8,829 million cubic feet estimated
(*d*) Various measurements and observations	
(*i*) Evaporation losses	5·58 feet depth per annum
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	This project was prepared by Mr. P. Davis on the Silauria river, one of the tributaries of the Mahanadi to supplement the flow in the river during periods of low supply in *kharif* seasons and to supply for *rabi* crop. Construction of the work was started in the year 1914-15 as soon as the headworks construction staff could be released for the purpose. The concrete cut-off trench was built before the monsoon of 1915, after which the construction was suspended for reasons connected with the war. A partial failure of the river supplies in the year 1917 made clear the imperative need for proceeding with the construction of the reservoir and this was resumed towards the end of that year.
(2) Personnel	Mr. P. Davis, Superintending Engineer, Mr. E. L. Glass, Superintending Engineer, Mahanadi Circle, Mr. S. N. Bhaduri, Executive Engineer.
(3) Bibliography	Public Works Department Central Provinces " Completion report of the Mahanadi Canal Project".

VII. 3. Kharung Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	69·1 feet (a portion)
(2) Location	Bilaspur District, Madhya Pradesh (Kharung river)
(3) Authority or owner	Madhya Pradesh Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1920
(6) Year of completion	1931
(7) Capital cost	
(*a*) Estimated	Rs. 13,66,587
(*b*) Actual (works only)	Rs. 12,37,526 (Works only)
(8) Culturable area commanded by the project	123,894 acres
(9) Area irrigated	42,294 acres
(10) Means of access	It is situated 21 miles north-east of Bilaspur town in the Bilaspur District, and is accessible from Bilaspur Railway Junction by road.

II. GEOPHYSICAL

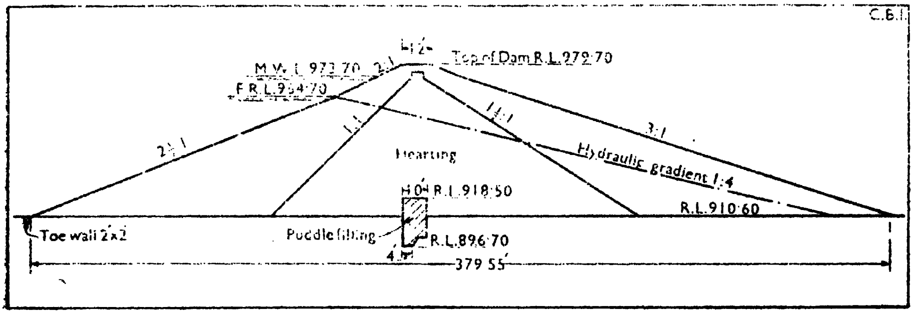
(1) Area of catchment	**237 square miles**
(2) Nature of catchment	Clay overlying light soil culturable land partly covered by forest area
(3) Mean annual precipitation	
(*a*) Rainfall	**44·72 inches**
(4) Total average annual yield of the catchment	**323, 462 acre feet**
(5) Climate	Hot with extreme variation in humidity
(6) Temperature conditions and variations	
(7) Rate of Flow	
(*a*) Maximum	**35,100 cusecs**
(*b*) Minimum	

(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	Water is generally clear but carries silt during rains
(10) Geological features	
(*a*) of foundations	Metamorphic rock overlain with boulders and *moorum*
(*b*) of catchment area	

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M. W. L.	R. L. 973·70
(*b*) F. R. L.	R. L. 964·70
(*c*) Area at M. W. L.	
(*d*) Area at F. R. L.	14·7 square miles
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	158,195 acre feet
(*b*) Live	1,55,900 acre feet
(*c*) Flood storage	98,691 acre feet
(*d*) Carry-over	2,296 acre feet



Cross Section of Kharung Dam

A. STATISTICAL

(3) Maximum height above the lowest point of foundations	96·24 feet
(4) Height above the lowest river bed at dam	69·1 feet
(5) Height of the top of the dam above the crest of the spillway or weir	15 feet

(6) Maximum width at level of foundations	379·55 feet
(7) Width at top	12 feet (A dam), 10 feet (B dam) and 5 feet (C and D dams)
(8) Slopes	
(*a*) Upstream	2 : 1 and 2½ : 1
(*b*) Downstream	2 : 1 and 3 : 1
(9) Length at top of the dam	7,309 feet
(*a*) Non-overflow	
(*i*) Main	6,909 feet
(*b*) Spillway	400 feet
(10) Cubic volume of the body of the dam	15,056,722 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	*Moorum*, loam, *matasi* and clay
(12) Specific gravity	
(*d*) Earthfill	
(13) Nature of protection and waterproofing of the upstream and downstream faces	2′×2′ toe wall on the upstream only and pitching on slopes
(14) Provision for dealing with seepage and drainage water	Seepage drains have been provided under both the A and B dams and they have been working satisfactorily. These were made 2 feet×2 feet and filled with 1½ feet boulders covered with 6 inches of moorum.
(15) Means of securing water tightness of the foundations of the dam	By means of core-wall filled with puddle
(21) Hydraulic gradient for which the embankment is designed	1 in 4
(22) Particular of the berm (if any) width and position	
(23) Position and form of the core wall (or other means of securing water tightness)	As per sketch
(24) Batter (if any) of the core-wall	1 in 4
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	'A' dam 27·14 feet, 'B' dam 33·6 feet
(26) Method of keying core wall or other wall in the underlying ground	Puddle trench
(27) Nature of material forming the core or other wall	Puddle of selected earth (*kankar* soil

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) Land submerged	
(*a*) Crown waste	Total land fully submerged 4,731·32 acres Total partly submerged 6,628 acres
(*b*) Proprietory	Forest area (not known)
(2) *Dislocation*	
(*a*) Villages	Submerged fully 7 villages Submerged partly in khalsa and zamindari 21 villages
(*b*) Families	350
(*c*) Population	2,100
(*d*) Roads	
(*ii*) District roads	Ratanpur Katghora Road
(*iii*) Village roads	No roads but cart tracks from village to village
(*f*) Temples, mosques etc.	One temple
(*g*) Graves etc.	
(*h*) Trees, gardens, pastures, houses, wells *etc.*	
(3) Compensation paid under each category of item (2)	Total amount paid Rs. 3,49,694/-

V. AUXILIARY WORKS

1) Surplusing works	The weir as constructed is 400 feet long, with a 9 feet flood lift and a drop of 10·06 feet from the crest to the floor on the downstream side ; no provision has been made for drop shutters. Its discharging capacity is 35,100 cusecs.
(2) Outlet works	Two sluices 6 feet×4·6 feet and 8 feet ×8 feet respectively fitted with Stoney's pattern gates.
) Scouring works	
) Inspection facilities	Sluice tower and tunnel under embankment accessible for inspection
5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	The original idea was a small canal scheme and proposals connected therewith were made in 1907 and 1908. Nothing further was done because Mahanadi and Tandula schemes absorbed all funds for several years and the project was reviewed in 1913 and in the same year orders for its reinvestigating were issued by the C.E. (Mr. R.H. Tickell) and the whole scheme was remodelled after inspection of site by Mr. A. J. Wadley C. E. and accordingly estimates were framed in accordance with his instructions. The scheme was sanctioned as an unproductive work.
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	No changes introduced in Dams except waste weir which differs from the design of the Project. According to the later there was a crest 460 feet long with 22 piers each 3 feet wide making 526 feet in all. This crest was to be split into two lengths by a divide wall with over falls of 12 feet and 4 feet respectively. The waste weir as constructed consists of a weir wall of 400 feet with a 9 feet flood lift and a drop of 10·06 feet from the crest to the floor.
(3) Noteworthy occurrences and accidents	The labour available locally was inadequate and so labour ponies and mules was imported and employed departmentally on a large scale and hence a large proposition of the work was done departmentally. Most of the ponies and mules died on account of cattle epedemic.
(4) Operation of the Dam (a) Regulation	There are two canals namely right bank canal and left bank canal and the regulation is done through sluices provided for.
(b) Silting of the reservoir	

(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	323,462 acre feet against 230,693 acre feet
(*d*) Various measurements and observations	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

This project had its beginning as far back as 1900 when information was being collected for the Irrigation Commission (1901-03). The original idea was a small canal scheme, and proposals connected therewith were made in 1902 and 1908. Nothing further was done because the Mahanadi and Tandula Schemes absorbed all the funds for several years but the Project was reviewed in 1913 and in the same year orders for its reinvestigation were issued by the Chief Engineer (Mr. R. H. Tickell).

The whole scheme was remodelled after an inspection of the site by the Chief Engineer, Irrigation Branch, (Mr. A. J. Wadley) at the end of 1917 and the construction estimate was framed in accordance with his instructions. The Project consists of a reservoir with two canals, on on either bank of the Kharung river and bears a close general resemblance to other large reservoir projects that have been built in the Madhya Pradesh. The construction estimate, amounting to Rs. 45,26,169 for works only and Rs. 59,16,945 including all charges, was sanctioned by the Secretary of State for India in Council as an, Unproductive Work in December, 1920.

(2) Personnel

1. Mr. P. V. Chance, Executive Engineer.
2. Mr. Bhakt Narain, Temporary Engineer.
3. Mr. D. F. S. MacArthur, Assistant Executive Engineer.
4. Mr. G. H. Forrest, Executive Engineer.
5. Mr. A. J. Harvey-Hurst, Assistant Engineer.
6. Mr. K. L. Jhanjee, Executive Engineer.
7. Mr. R. K. Batra, Assistant Executive Engineer.

(3) Bibliography

Public Works Department, Central Provinces, "Completion report of the Kharung tanks in the Bilaspur District".

VII. 4. Maniari Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	95 feet
(2) Location	Bilaspur District, Madhya Pradesh (Maniari river at Khuria)
(3) Authority or owner	Madhya Pradesh Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1924
(6) Year of completion	1933
(7) Capital cost	
(a) Estimated	Rs. 18,70,555
(b) Actual	Rs. 17,76,300
(8) Culturable area commanded by the project	
(9) Area irrigated	126,377 acres
(11) Means of access	It is situated at Khuria in the Mangeli tehsil of the Bilaspur District about 56 miles to the North-West of Bilaspur town and about 15 miles from Lormi in the same direction. Lormi is accessible from Kota Railway Station on the Bengal Nagpur Railway.

II. GEOPHYSICAL

(1) Area of catchment	310 square miles
(2) Nature of catchment	Forest covered hills with steep slopes
(3) Mean annual precipitation	
(a) Rainfall	At Khuria 43·37 inches At Pandaria 39·33 inches
(4) Total average annual yield of the catchment	220,661 acre feet

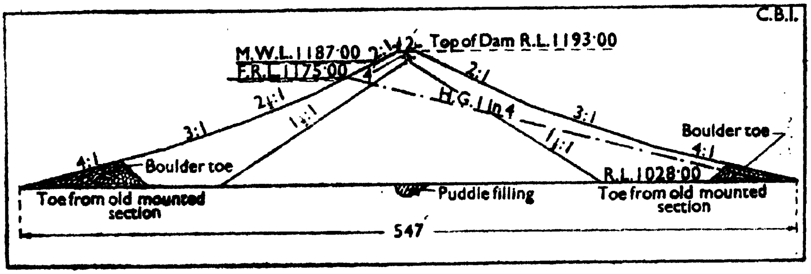
II. GEOPHYSICAL—contd.

(5) Climate (6) Temperature conditions and variations	Hot with extreme variation in humidity
(7) Rate of Flow	
(a) Maximum	
(b) Minimum	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	Water is generally clear but it carries silt during rains
(10) Geological features	
(a) of foundations	Metamorphic rock overlain with 12 feet sand in river portion and yellow clay eslewhere
(b) of catchment area	Clay overlying light soil and metamorphic rock or shale. Mostly it is forest covered hill area
(11) Earthquake (Zone and intensities)	

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(a) M.W.L.	R. L. 1187·00
(b) F. R. L.	R. L. 1175·00
(c) Area at M. W. L.	13·13 square miles
(d) Area at F. R. L.	9·75 square miles
(e) Maximum length	
(f) Maximum width	
(g) Length of periphery	
2) Capacity of the reservoir	
(a) Gross	122,635 acre feet
(b) Live	119,743 acre feet
(c) Flood storage	55,119 acre feet
(d) Carry-over	2,893 acre feet



Cross Section of Maniari Dam

(3) Maximum height above the lowest **point** of foundations	113 feet
(4) Height above the lowest river bed **at** dam	95 feet
(5) Height of the top of the dam above **the** crest of the spillway or weir	18 feet
(6) Maximum width at level of foundation	547 feet
(7) Width at top	12 feet (Main Dam) 6 feet (Subsidiary Dam)
(8) Slopes	
(*a*) Upstream	4 : 1, 3 : 1, 2½ : 1 and 2 : 1 (Main Dam) 2 : 1 (Subsidiary Dam)
(*b*) Downstream	4 : 1, 3 : 1, 2½ : 1 and 2 : 1 (Main Dam) 2 : 1 (Subsidiary Dam)
(9) Length at top of the dam	
(*a*) Non-overflow	9,015 feet
(*i*) Main	6,616 feet
(*ii*) Subsidiary	2,141 feet
(*b*) Spillway	258 feet
(10) Cubic volume of the body of the **dam**	38,460,067 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Core of black earth and flanked by *moorum* and kochar
(12) Specific gravity	
(*d*) Earthfill	
(13) Nature of protection and waterproofing of the upstream and downstream faces	Stone toe wall and dry stone pitching in upstream. Stone toe wall and turfing in downstream
(14) Provision for dealing with seepage and drainage water	Seepage drains filled with stones
(15) Means of securing water tightness **of** the foundation of the dam	By means of core-wall filled with puddle
(21) Hydraulic gradient for which the embankment is designed	1 in 4
(22) Particular of the berm (if any) width and position	
(23) Position and form of the core wall (or other means of securing water tightness).	As per sketch
(24) Batter (if any) of the core wall	1 in 4

(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	45 feet
(26) Method of keying core-wall or other wall in the underlying ground	Puddle trench
(27) Nature of material forming the core or other wall	Selected earth (Puddle)

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) Land submerged		
(a) Crown waste	Reserved forest 7193 acres	
(b) Proprietory	2 Villages Khuria Area —	985 acres
	Lingbanda „ —	123 acres
		1108 acres
(2) Dislocation		
(a) Villages	Submerged fully Forest villages same as above	
(b) Families	25	
(c) Population	100	
(d) Roads		
(ii) District roads	Only forest road	
(f) Temples, mosques *etc.*	One temple in existence in Village Khuria	
(h) Trees, gardens, pastures, houses, wells *etc.*	About 20 mangoe trees existing	
		Rs.
(3) Compensation paid under each category of item (2)	Total compensation paid	24,342
	+ To Forest Depot	27,075
	+ To Forest trees	42,377
	Total	93,794

V. AUXILIARY WORKS

(1) Surplusing works	The waste weir, 258 feet long, is located on a small spur of granite. It consists of a low masonry wall with a streamlined crest of cement concrete. Its discharging capacity at present is 34,800 cusecs with a depth of 12 feet of water.
([illegible]) Outlet works	Two sluice tunnels fitted with a patent Stoney sluice gate and an emergency gate, supplied by Messrs Ransoms and Rapier.
([illegible]) Scouring works	
(4) Inspection facilities	Sluice tower and tunnel under embankment accessible for inspection

(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	Special difficulties were encountered during construction of the work. There being a prevalence of kankar soil, it was considered to provide a thick blanket of moorum underneath and round masonry works though at a very great expense. In the puddle trench, running sand was encountered on the left bank of the river between R. D. 1,040 and R.D. 1,190 and the sides of the trench had to be shored with steel sheet piling.
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	The section of the dam modified, and the length of waste weir was reduced and flood lift increased in order to found the entire waste weir on rock.
(3) Noteworthy occurrences and accidents	The labour available locally was inadequate so in accordance with the Local Government's decision, labour was imported and employed departmentally on a very large scale. A large proportion of the work was constructed departmentally. Nearly 21,000 labourers were imported and a sum of Rs. 1,16,000 was expended in advance, of which only 4 per cent. had to be written off as irrecoverable.
(4) Operation of the dam	
(*a*) Regulation	**Sluice gates are provided**
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	**220,661 acre feet against 1,533,723 acre feet estimated**

(d) Various measurements and observations	
(*i*) Evaporation losses	3·05 feet per annum
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	Seepage drain provided and functioning well. No quantitative records have been maintained
(*e*) Fish culture	
(*f*) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

Lastly, in August 1913 the Maniari scheme was again placed on the programme of schemes to be investigated. Mr. Harriott had been in favour of a left bank channel to irrigate the Maniari-Arpa doab while Mr. Clayton, who succeeded him, had been in favour of a right bank channel to irrigate the Maniari-Rohan doab, as he considered that the former doab could be more cheaply served by the Khori reservoir supplemented if necessary, by a feeder from the Arpa river. Further investigation of the Maniari scheme was again postponed in September 1913 until the Khori reservoir scheme had been investigated.

In October 1917 the project division was formed with the special object of exploring the possibilities of irrigation in the Bilaspur district and precedence was given to projects in the Janjgir and Bilaspur tehsils. As the Khori reservoir scheme was dropped in 1916 and the investigation of the Arpa scheme, as a substitute, was completed in 1919, attention was again diverted to the Maniari scheme early in 1920. Mr.

Dewar, Deputy Commissioner, Bilaspur, was asked to express his opinion on the scheme, his reply, which was most favourable was received in January 1921 and the preliminary investigation of the Scheme was at once taken up and was completed before the monsoon broke. The preliminary estimate for the work amounted to Rs. 62,47,052 inclusive of all charges. In C. P. P.W.D., letter No. 279-B-W. I., dated the 26th January 1922, the Local Government's approval to the investigation of the scheme in detail for the irrigation of 66,000 acres of rice was accorded. The detailed investigation was completed in March 1923 and the estimate for the work, amounting to Rs. 47,19,597 for works only, or Rs. 61,69,505 including all charges, was sanctioned by the Local Government in C. P., P.W.D. letter No. 115-G.-W. I-23, dated the 20th March 1924.

Mr. Bhakt Narain, Executive Engineer, was responsible for the investigation and initial stages of the construction of the work and Mr. G. D. Agarwal for completing the construction satisfactorily.

(2) Personnel

1. Major Rivett-Carnac, Superintending Engineer.
2. Mr. Bhakt Narain, Executive Engineer.
3. Mr. R. K. Batra, Assistant Executive Engineer.
4. Mr. Raunaqi Ram, Assistant Engineer.

(3) Bibliography

Public Works Department, Central Provinces "Completion report of the Maniari reservoir project in the Bilaspur District".

CHAPTER VIII

TAPTI BASIN

VIII. 1. Mukti Dam

Earthen

1. GENERAL

(1) Height above the lowest river bed	65·10 feet
(2) Location	West Khandesh district, Bombay State (Mukti *Nala*)
(3) Authority or owner	Bombay Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1869
(6) Year of completion	1873
(7) Capital cost	
(*a*) Estimated	
(*b*) Actual	Rs. 4,68,621
(8) Culturable area commanded by the project	
(9) Area irrigated	
(11) Means of access	It is accessible from Dulia Railway Station (Chalisgaon Dhulia line Great Indian Peninsular Railway) by road, distance about four miles

II. GEOPHYSICAL

(1) Area of catchment	34·22 square miles
(2) Nature of catchment	Hilly
(3) Mean annual precipitation	
(*a*) Rainfall	20·58 inches
(4) Total average annual yield of the catchment	29,640 acre feet
(5) Climate	Hot
(6) Temperature conditions and variations	50°F to 1,15°F
(7) Rate of flow	
(*a*) Maximum	
(*b*) Minimum	

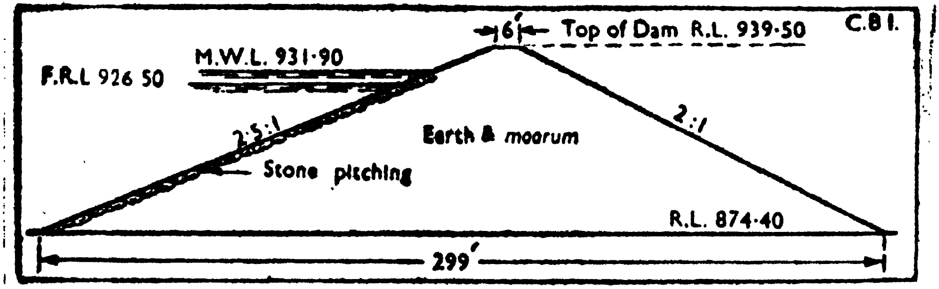
II. GEOPHYSICAL—contd.

(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	Sweet, suitable for irrigation purposes
(10) Geological features	
(a) of foundations	Soil and *Moorum* over lying Deccan trap
(b) of catchment area	Earth and *Moorum* overlying Deccan trap

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(a) M. W. L.	R. L. 931·90
(b) F. R. L.	R. L. 926·50
(c) Area at M. W. L.	0·79 square mile
(d) Area at F. R. L.	
(e) Maximum length	
(f) Maximum width	
(g) Length of periphery	
(2) Capacity of the reservoir	
(a) Gross	
(b) Live	7,347 acre feet
(c) Flood storage	
(d) Carry-over	2,215 acre feet



Cross section of Mukti Dam

(3) Maximum height above the lowest point of foundations	68·25 feet
(4) Height above the lowest river bed at dam	65·1 feet
(5) Height of the top of the dam above the crest of the spillway or weir	13·0 feet

(6) Maximum width at level of foundations	299·0 feet
(7) Width at top	6·0 feet
(8) Slopes	
(*a*) Upstream	$2\frac{1}{2}$ to 1
(*b*) Downstream	2 to 1
(9) Length at top of the dam	1900 feet
(*a*) Non-overflow	
(*i*) Main	1,900 feet
(*b*) Spillway or waste weir	Waste weir 890 feet long on east and 700 feet drowned masonry weir on west
(10) Cubic volume of the body of the dam	

B. OTHERS

(11) Material of which the dam is constructed	Soil and *moorum*
(12) Specific gravity	
(*d*) Earthfill	
(13) Nature of protection and waterproofing of the upstream and downstream faces	Stone pitching upstream
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundations of the dam	By core and puddle walls
(16) Hydraulic gradient for which the embankment is designed	
(17) Particular of the berm (if any) width and position.	
(18) Position and form of the core-wall (or other means of securing water tightness)	
(19) Batter (if any) of the core-wall	
(20) Maximum depth below ground surface of core-wall or other means of securing water tightness	
(21) Method of keying core-wall or other wall in the under-lying ground	Puddle wall rests over the cut and dressed rocks
(22) Nature of material forming the core or other wall	Core-wall of selected earth with a puddle core-wall inside

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory
(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads
    (*i*) Highways
    (*ii*) District Roads
    (*iii*) Village Roads
  (*e*) Railway Lines
  (*f*) Temples, mosques, etc.
  (*g*) Graves, etc.
  (*h*) Trees, gardens, pastures, houses, wells, etc.
  (*i*) Bridges
(3) Compensation paid under each category of item (2)
(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Masonry waste weir 3 feet clear overfall, 890 feet long on east for emergency use. 700 feet drowned masonry weir on west on open ground; total discharging capacity 32,265 cusecs, 11,027 cusecs for higher weir, 21,238 cusecs for lower weir.
(2) Outlet works	3 Cast iron pipes with sluice gates
(3) Scouring works	
(4) Inspection facilities	Foot bridge leading to Valve outlet, valve tower
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features
(2) Charges introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents	
(4) Operation of the dam	
(*a*) Regulation	By means of screwgates
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	
(*d*) Various measurements and observations	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	
(2) Personnel	The site for the dam was selected in the year 1868 by Col. Fife, Che Engineer for Irrigation.
(3) Bibliography	

VIII. 2. Hartala Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	51·5 feet
(2) Location	East Khandesh district, Bombay State (local stream)
(3) Authority or owner	Bombay Government
(4) Purpose—Main and subsidiary	Irrigation and domestic supply
(5) Year of commencement	1870
(6) Year of completion	1875
(7) Capital cost	
(*a*) Estimated	Rs. 73,382
(*b*) Actual	Rs. 73,382
(8) Culturable area commanded by the project	584 acres
(9) Area irrigated	420 acres
(11) Means of access	It is accessible from Warangaon railway station by a motorable road.

II. GEOPHYSICAL

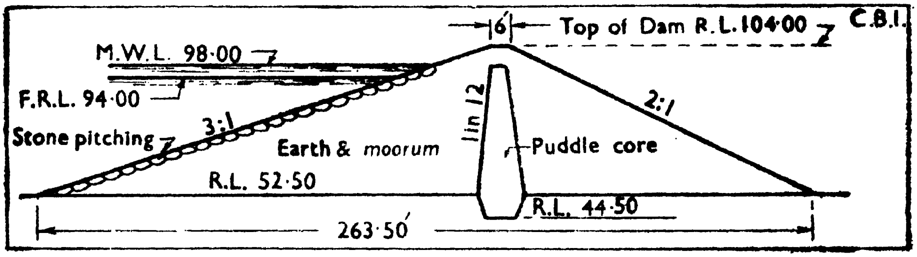
(1) Area of catchment	6·8 square miles
(2) Nature of catchment	*Moorum* soil
(3) Mean annual precipitation	
(*a*) Rainfall	26·32 inches
(4) Total average annual yield of the catchment	1,723 acre feet
(5) Climate	Hot
(6) Temperature conditions and variations	
(7) Rate of Flow	
(*a*) Maximum	
(*b*) Minimum	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	
(10) Geological features	

(*a*) of foundations	*Moorum* soil overlying Deccan trap
(*b*) of catchment area	Earth and *moorum* overyling Deccan trap

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M. W. L.	R. L. 98·00 (from an arbitrary datum)
(*b*) F. R. L.	R. L. 94·00 (from an arbitrary datum)
(*c*) Area at M. W. L.	
(*d*) Area at F.R. L.	0·744 square mile
(*e*) Maximum length	1·2 miles
(*f*) Maximum width	1 mile
(*g*) Length of periphery	6 miles
(2) Capacity of the reservoir	
(*a*) Gross	3,099 acre feet
(*b*) Live	3,096 acre feet
(*c*) Flood storage	
(*d*) Carry-over	



Cross Section of Hartala Dam

(3) Maximum height above the lowest point of foundations	59·5 feet
(4) Height above the lowest river bed at dam	51·5 feet
(5) Height of the top of the dam above the crest of the spillway or weir	10 feet
(6) Maximum width at level of foundation	263·5 feet
(7) Width at top	6 feet
(8) Slopes	
(*a*) Upstream	3 : 1
(*b*) Downstream	2 : 1

(9) Length at top of the dam	**1,500 feet**
(*a*) Non-overflow	
(*i*) Main	**1,364 feet**
(*b*) Spillway or waste weir	**136 feet**
(10) Cubic volume of the body of dam	
(11) Material of which the dam is constructed	*Moorum* soil
(12) Specific gravity	
(*d*) Earthfill	
(13) Nature of protection and waterproofing of the upstream and downstream faces	Stone pitching on upstream side
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundations of the dam	By means of puddle core-wall
(21) Hydraulic gradient for which the embankment is designed	
(22) Particular of the berm (if any) width and position	
(23) Position and form of the core-wall (or other means of securing water tightness)	As per cross section
(24) Batter (if any) of the core wall	1 in 12
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness.	8 feet
(26) Method of keying core-wall or other wall in the underlying ground	By means of trenching
(27) Nature of material forming the core or other wall	Puddle wall of clay

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory
(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads
    (*i*) Highways
    (*ii*) District Roads
    (*iii*) Village Roads

(*e*) Railway Lines	
(*f*) Temples, mosques, etc.	
(*g*) Graves, etc.	
(*h*) Trees, gardens, pastures, houses, wells, etc.	
(*i*) Bridges	
(3) Compensation paid under each category of item (2)	
(4) Method of compensating for land of dispossessed landholders	

V. AUXILIARY WORKS

(1) Surplussing works	Masonry waste weir 136 feet long, maximum discharging capacity 4,265 cusecs
(2) Outlet works (3) Scouring works	Small outlet sluice in masonry portion
(4) Inspection facilities	6 feet Earthen path on the dam
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurrences and accidents	The dam had a breach due to abnormal high flood and repairs were effected during the period of four years from 1871-1875
(4) Operation of the dam	
(*a*) Regulation	Ordinary outlet closed and opened by minor wooden pins
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	
(*d*) Various measurements and observations	

(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	The work has been found a failure as in the year of bad rains, the reservior does not fill up, and in good season crops do not require irrigation.

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

(3) Bibliography

VIII. 3. Parsul Dam

(Earthen)

(1) Height above the lowest river bed	62 feet
(2) Location	Malegaon taluka, Nasik District Bombay State (Parsul River)
(3) Authority or owner	Bombay Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1883
(6) Year of completion	1894
(7) Capital cost	
(*a*) Estimated	Rs. 2,12,331
(*b*) Actual	Rs. 2,05,227
(8) Culturable area commanded by the project.	3,197 acres out of command of 3,337 acres
(9) Area irrigated	1,000 acres and due to improvements in 1946 it is 1,783 acres
(11) Means of access	It is situated North of mile stone No. 161 from (Bombay) on the Bombay Agra Road and is about 2 miles from there. It has no regular approach road. The nearest railway station connected by road is Lasalgaon (Great Indian Peninsular Railway) and is 22 miles from the dam.

II. GEOPHYSICAL

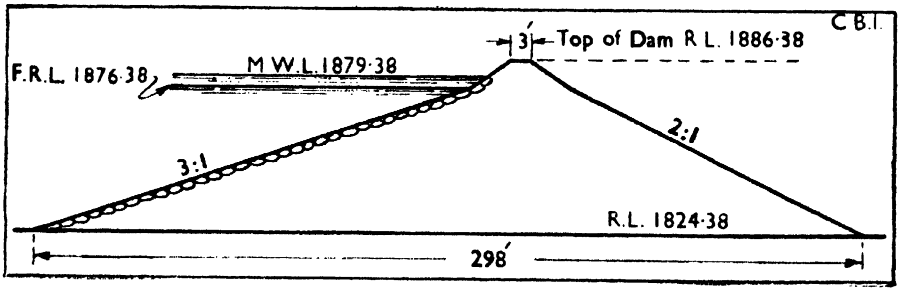
(1) Area of catchment	17·33 square miles
(2) Nature of catchment	Hilly and steep. Out of 17·33 square miles, 12 square mile are on elevated plateau in Chandore Ridge.
(3) Mean annual precipitation	
(*a*) Rainfall	28·0 inches

(4) Total average annual yield of the catchment	4,380 acre feet
(5) Climate	Tropical (Hot from April to end of May. Heaviest rain normally occurs in August)
(6) Temperature conditions and variations	Maximum temperature 107°F Minimum temperature 50°F
(7) Rate of Flow	
(*a*) Maximum	6,640 cusecs
(*b*) Minimum	
(8) Detritus charge of the stream	Shallow soil with rock and erosive
(9) Character (chemical) of the water stored in the reservoir	Sweet, and suitable for irrigation purpose
(10) Geological features	
(*a*) of foundations	(*a*) Hard trap rock for key trench, and hard *moorum* under embankment
(*b*) of catchment area	(*b*) Hilly and steeply sloping

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M. W. L.	R. L. 1879·38
(*b*) F. R. L.	R. L. 1876·38
(*c*) Area at M. W. L.	0·24 square miles
(*d*) Area at F. R. L.	0·23 square miles
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	2,859 acre feet
(*b*) Live	2,725 acre feet
(*c*) Flood storage	
(*d*) Carry-over	



Cross Section of Parsul Dam.

(3) Maximum height above the lowest point of foundations	
(4) Height above the lowest river bed at dam	62 feet
(5) Height of the top of the dam above the crest of the spillway or weir	10 feet
(6) Maximum width at level of foundations	298 feet
(7) Width at top	2 to 3 feet
(8) Slopes	
(*a*) Upstream	As per sketch
(*b*) Downstream	
(9) Length at top of the dam	2,770 feet
(*a*) Non-overflow	
(*i*) Main	2,270 feet
(*ii*) Subsidiary	
(*b*) Spillway	500 feet
(10) Cubic volume of the body of the dam	
(11) Material of which the dam is constructed	" Man " soil and *moorum* for side " Man " and black soil for hearting
(12) Specific gravity	
(*d*) Earthfill	
(13) Nature of protection and waterproofing of the upstream and downstream faces	Upstream side pitching of stone tailing upwards and on downstream blanket of *moorum* with Man soil
(14) Provision for dealing with seepage and drainage water	
(20) Means of securing water tightness of the foundations of the dam	By concrete trench at bottom in the centre of the dam
(21) Hydraulic gradient for which the embankment is designed	
(22) Particular of berm (if any) width and position	
(23) Position and form of the core-wall (or other means of securing water tightness)	There is no regular core wall, but there exists a concrete trench 8 feet to 10 feet wide at bottom in the centre of the dam
(24) Batter (if any) of the core-wall	
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	

(26) Method of keying core-wall or other wall in the underlying ground	Concrete trench wall
(27) Nature of material forming the core or other walls	There is a concrete trench 8 to 10 feet wide at bottom, in centre of the dam.

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*	
(*a*) Crown waste	152 acres
(*b*) Proprietory	
(2) *Dislocation*	
(*a*) Villages	
(*b*) Families	
(*c*) Population	
(*d*) Roads :	
(*i*) Highways	
(*ii*) District Roads	
(*iii*) Village Roads	
(*e*) Railway Lines	
(*f*) Temples, mosques, *etc.*	
(*g*) Graves, *etc.*	
(*h*) Trees, gardens, pastures, houses, wells, *etc.*	
(*i*) Bridges	
(3) Compensation paid under each category of item (2)	
(4) Method of compensating for land of dispossessed landholders	Cash

V. AUXILIARY WORKS

(1) Surplussing works	Waste weir of channel cut into rock 500 feet long with 4 feet designed depth of water over crest ; discharging capacity is 12,800 cusecs.
(2) Outlet works	Two outlet sluices worked with rods laid along the slope of the dam.
(3) Scouring works	
(4) Inspection facilities	
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the Dam	
(*a*) Regulation	
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	
(*d*) Various measurements and observations	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilization of the dam	'Man' soil proved better than black soil for hearting and core.

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	(1) The work was commenced as a famine relief work in February, 1883 and from September 1883 it was executed as an ordinary irrigation work and completed in year 1888-89. For additional supply of tank, catchment of 9 square miles of Tiroli *Nala* was diverted by a feeder channel and weir which gave 39 million cubic feet extra. This work was completed in the year 1946.
(2) Personnel	
(3) Bibliography	

VIII 4. Dedargaon Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	52·92 feet
(2) Location	West Khandesh district Bombay State, (Anwar *Nala*)
(3) Authority or owner	Dhulia Municipality, Bombay Government.
(4) Purpose—Main and Subsidiary	Domestic water supply
(5) Year of commencement	1892
(6) Year of completion	1897
(7) Capital cost	
(*a*) Estimated	
(*b*) Actual	
(11) Means of access	It is accessible by road from Dhulia railway station (Chalisgaon railway line) on Great Indian Peninsular Railway.

II. GEOPHYSICAL

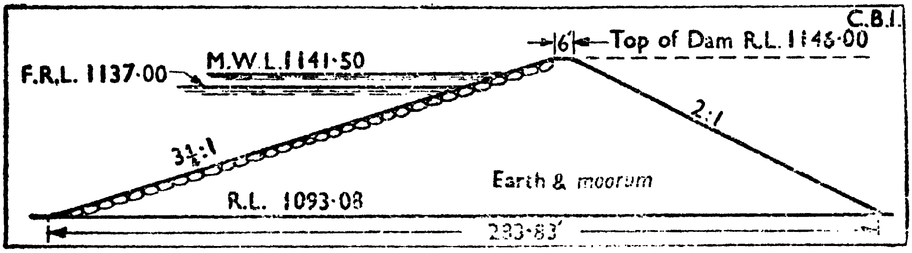
(1) Area of catchment	14 square miles
(2) Nature of catchment	Soil and *moorum*
(3) Mean annual precipitation	
(*a*) Rainfall	22·91 inches
(4) Total average annual yield of the catchment	
(5) Climate	Hot
(6) Temperature conditions and variations	
(7) Rate of Flow	
(*a*) Maximum	
(*b*) Minimum	
(8) Detritus charge of the stream	Brushwood and silt during monsoon
(9) Character (chemical) of the water stored in the reservoir	Sweet
(10) Geological features	

(*a*) of foundations	*Moorum* soil overlying Deccan trap
(*b*) of catchment area	Hilly and small depth of soil overlying Deccan trap

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M. W. L.	R. L. 1141·50
(*b*) F. R. L.	R L 1137·00
(*c*) Area at M. W. L.	0·40 square mile
(*d*) Area at F. R. L.	
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	(*a*) 3,719 acre feet
(*b*) Live	



Cross Section of Dedargaon Dam

(3) Maximum height above the lowest point of foundations	
(4) Height above the lowest river bed at dam	52·92 feet
(5) Height of the top of the dam above the crest of the spillway or weir	9 feet
(6) Maximum width at level of foundations	283·83
(7) Width at top	6 feet
(8) Slopes	
(*a*) Upstream	As per sketch
(*b*) Downstream	
(9) Length at top of the dam	Earthen portion 1,400 feet Masonry portion 555 feet

(*a*) Non-overflow	
(*i*) Main	1,400 feet
(*b*) Spillway	555 feet
(10) Cubic volume of the body of the dam	

B. OTHERS

(11) Material of which the dam is constructed	Earth and *moorum* ; weir portion is of masonry
(12) Specific gravity	
(*d*) Earthfill	
(13) Nature of protection and waterproofing of the upstream and downstream faces	Stone pitching on upstream side
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundations of the dam	
(21) Hydraulic gradient for which the embankment is designed	
(22) Particular of the berm (if any) width and position	
(23) Position and form of the core wall (or other means of securing water tightness)	
(24) Batter (if any) of the core wall	
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	
(26) Method of keying core-wall or other wall in the underlying ground	
(27) Nature of material forming the core or other wall	

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory
(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads

(*i*) Highways
(*ii*) District Roads
(*iii*) Village Roads
(*e*) Railway Lines
(*f*) Temples, mosques, etc.
(*g*) Graves, etc.
(*h*) Trees, gardens, pastures, houses, wells, etc.
(*i*) Bridges
(3) Compensation paid under each category of item (2).
(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Masonry waste weir 550 feet long discharging capacity 13,891 cusecs.
(2) Outlet works	Outlet consists of masonry wall provided with cast iron pipes with valves
(3) Scouring works	
(4) Inspection facilities	
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features
(2) Changes introduced in the plans of the dam and in the method of carrying out the work
(3) Noteworthy occurrences and accidents
(4) Operation of the dam
(a) Regulation
(*b*) Silting of the reservoir
(*i*) Total silt deposited
(*ii*) Rate of silting
(*iii*) Density of the silt deposited
(*iv*) Rate of advancement of delta
(*c*) Actual yield as against estimated
(*d*) Various measurements and observations

(*i*) Evaporation losses
(*ii*) Sweating below the dam
(*iii*) Temperature measurements
(*iv*) Seepage and regeneration
(*e*) Fish culture
(*f*) Antimalaria measures
(5) Recreation facilities
(6) Lessons to be learnt from the construction and utilisation of the dam

VI. BIBLIOGRAPHY AND HISTORICAL

(1) Historical
(2) Personnel
(3) Bibliography

VIII. 5. Chankapur Dam

(Masonry)

I. GENERAL

(1) Height above the lowest river bed	101 feet
(2) Location	Nasik district, Bombay State, (Girna River)
(3) Authority or owner	Government of Bombay
(4) Purpose—Main and Subsidiary	Irrigation
(5) Year of commencement	1903
(6) Year of completion	1911
(7) Capital cost	
(a) Estimated	Rs. 17,69,569
(b) Actual	Rs. 13,45,349
(8) Culturable area commanded by the project	25,200 acres
(9) Area irrigated	9,744 acres
(11) Means of access	The nearest large Railway Station is Manmad, which is on the main line of Great Indian Peninsular Railway and the tank is about 52 miles from this station by road *via* Chandor, Devla and Kalwan.

II. GEOPHYSICAL

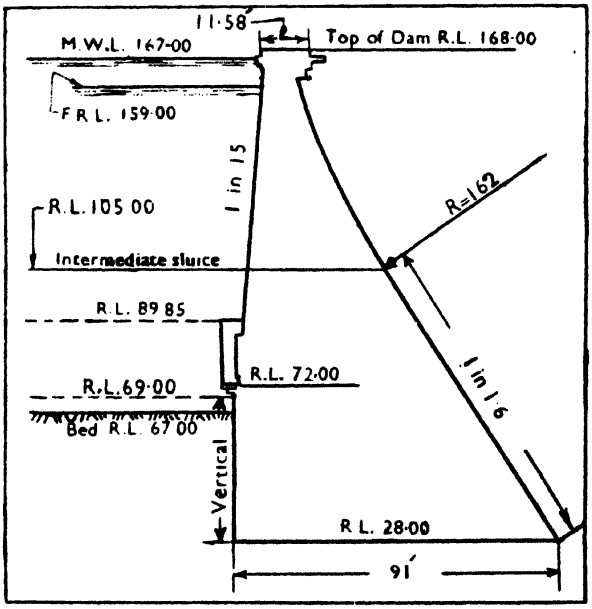
(1) Area of catchment	100 square miles
(2) Nature of catchment	
(3) Mean annual precipitation	
(a) Rainfall	(a) 51·50 inches
(4) Total average annual yield of the catchment	118,260 acre feet
(5) Climate	Hot from April to end of May, and heaviest rainfall occurs in August.
(6) Temperature conditions and variations	Maximum temperature 107° F. minimum temperature 50° F .
(7) Rate of Flow	
(a) Maximum	37,800 cusecs
(b) Minimum	No flow

(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	Sweet and suitable for irrigation purposes
(10) Geological features	
(*a*) of foundations	Hard rock
(*b*) of catchment area	Hilly tract and steep

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M. W. L.	R. L. 167 from arbitrary datum (or 100 feet from river bed)
(*b*) F. R. L.	R. L. 159 from arbitrary datum (or 92 feet from river bed)
(*c*) Area at M. W. L.	2·1/3 square miles
(*d*) Area at F. R. L.	1·31 square miles
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	35,527 acre feet.
(*b*) Live	33,609 acre feet
(*c*) Flood storage	
(*d*) Carry-over	



Cross Section of Chankapur Dam

(3) Maximum height above the lowest point of foundations	140 feet
(4) Height above the lowest river bed at dam.	101 feet
(5) Height of the top of the dam above the crest of the spillway or weir	9 feet
(6) Maximum width at level of foundation	91 feet
(7) Width at top	11·58 feet, 10 feet + 1·58 feet (Carbelled portion)
(8) Batter of faceslopes	
(a) Upstream	As. per cross section
(b) Downstream	
(9) Length at top of the dam	1,506 feet
(a) Non-overflow	
(i) Main	583 feet
(b) Spillway	923 feet
(10) Cubic volume of the body of the dam	

B. OTHERS

(11) Material of which the dam is constructed	Rubble masonry
(12) Specific gravity	
(a) Masonry	2·46
(13) Nature of protection and waterproofing of the upstream and downstream faces	Dam is made of strong uniform rubble masonry with downstream facing of hardstone and is water tight.
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundations of the dam	
16) Contraction joints	
(17) Principal stresses in the masonry with a note of methods of calculations employed	
(18) Maximum pressure on foundations	
(19) Uplift pressure, calculated or measured	
(20) Measures adopted for preventing or counteracting uplift pressures	

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*	1,492 acres
(a) Crown waste	
(b) Proprietory	

(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads
    (*i*) Highways
    (*ii*) District Roads
    (*iii*) Village Roads
  (*e*) Railway Lines
  (*f*) Temples, mosques, etc.
  (*g*) Graves, etc.
  (*h*) Trees, gardens, pastures, houses, wells, etc.
  (*i*) Bridges
(3) Compensation paid under each category of item (2)
(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Masonry waste weir on North and South sides 488 feet and 435 feet long with 36 and 31 automatic gates respectively ; each gate being 10 feet by 8 feet. Discharging capacity is 47,109 cusecs
(2) Outlet works	There are seven undersluices and two upper sluices all 10 feet by 4 feet fitted with Stoney's patent sluice gates. Out of these seven undersluices, four undersluices were closed in the year 1931 and the remaining three are proposed to be closed shortly
(3) Scouring works	
(4) Inspection facilities	
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	Besides the main dam there are two embankments constructed one at North and South. These are not directly in continuation of main dam but close the depressions in the ridge bounding the basin

(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurrences and accidents	Considerable difficulty was experienced while excavating foundation for main dam. Solid rock was met 18 feet below the expected level In year 1938 in the month of October there were very heavy rains on 6th at night and northern embankment was breached at 4 places as waste weir gates on northern side could not be opened nor they worked automatically and the flood discharge overtopped the dam. No damage was caused to the main dam
(4) Operation of the dam	By sluices 10 feet by 4 feet with Stoney patent gates.
(*a*) Regulation	By opening gates by lifting winch
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	
(*d*) Various measurements and observations	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

Executive Engineers :—

- (*i*) Mr. F. D. Campbell,
- (*ii*) Mr. A. Hill, C.I.E., F.C.H. A.M.I.C.E.,
- (*iii*) Mr. H. O. B. Shoubridge A.M.I.C.E.,
- (*iv*) Mr. C. Mandy,
- (*v*) Mr. J. B. S. Thubron,
- (*vi*) Mr. S. C. Mould, B.A.,
- (*vii*) Mr. T. S. Pipe, B.Sc., A.M.I.C.E., Assistant Engineer.
- (*viii*) Mr. S. K. Bhagvat, L.C.E., Assistant Engineer.

(3) Bibliography

VIII-6. Talwada Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	54·0 feet
(2) Location	West Khandesh district, Bombay State, Amratwati river
(3) Authority or owner	Bombay Government
(4) Purpose—Main and Subsidiary	Irrigation
(5) Year of commencement	1899
(6) Year of completion	1915
(7) Capital cost	
(a) Estimated	
(b) Actual	
(8) Culturable area commanded by the Project	
(9) Area irrigated	
(11) Means of access	It is accessible from Ranala Railway Station (Tapti valley line Bombay Baroda & Central India Railway) by a *Kacha* road

II. GEOPHYSICAL

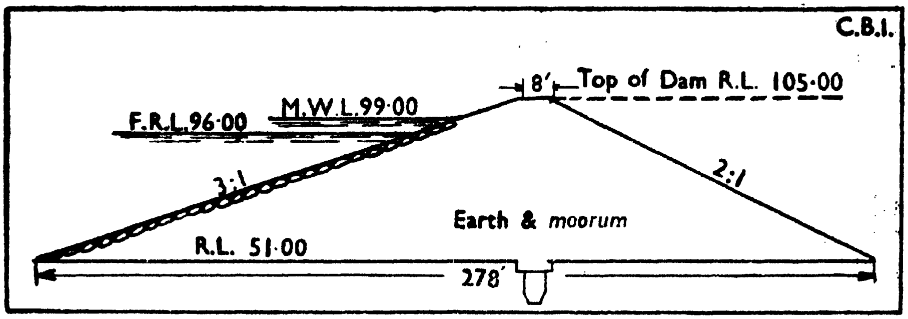
(1) Area of catchment	10·5 square miles
(2) Nature of catchment	*Moorum* soil
(3) Mean annual precipitation	
(a) Rainfall	17·38 inches
(4) Total average annual yield of the catchment	1,750 acre feet
(5) Climate	Hot
(6) Temperature conditions and variations	
(7) Rate of flow	
(a) Maximum	
(b) Minimum	
(8) Detritus charge of the stream	Brushwood and silt laden water during monsoon period

(9) Character (chemical) of the water stored in the reservoir	Sweet
(10) Geological features	
(*a*) of foundations	*Moorum* soil over-lying Deccan trap
(*b*) of catchment area	*Moorum* soil and overlying Deccan trap

III. TECHNICAL

A. STATISTICAL

(1) Reservoir data	
(*a*) M. W. L.	R. L. 99·00 from an arbitrary datum
(*b*) F. R. L.	R. L. 96·00 from an arbitrary datum
(*c*) Area at M.W.L.	0·31 square mile
(*d*) Area at F. R. L.	
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	2,691 acre feet
(*b*) Live	
(*c*) Flood storage	
(*d*) Carry-over	



Cross Section of Talwada Dam

(3) Maximum height above the lowest point of foundations	60·0 feet
(4) Height above the lowest river bed at dam	54 feet
(5) Height of the top of the dam above the crest of the spillway or weir	9 feet
(6) Maximum width at level of foundation	278 feet

(7) Width at top	8 feet
(8) Slopes	
(*a*) Upstream	3 : 1
(*b*) Downstream	2 : 1
(9) Length at top of the dam	
(*a*) Non- overflow	
(*i*) Main	
(*ii*) Subsidiary	
(10) Cubic volume of the body of the dam	

B. OTHERS

(11) Material of which the dam is constructed	Earth and *moorum*
(12) Specific gravity	
(*a*) Earthfill	
(13) Nature of protection and waterproofing of the upstream and downstream faces	Stone pitching on upstream side
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundations of the dam	In the gorge portion it is secured by means of puddle core-wall and concrete trench underneath
(21) Hydraulic gradient for which the embankment is designed	
(22) Particular of the berm (if any) width and position	
(23) Position and form of the core-wall (or other means of securing water tightness)	
(24) Batter (if any) of the core-wall	
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	
(26) Method of keying core-wall or other wall in the underlying ground	
(27) Nature of material forming the core or other wall	Puddle and concrete

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*

(*a*) Crown waste

(*b*) Proprietory

(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads
    (*i*) Highways
    (*ii*) District Roads
    (*iii*) Village Roads
  (*e*) Railway Lines
  (*f*) Temples, mosques, etc.
  (*g*) Graves, etc.
  (*h*) Trees, gardens, pastures, houses, wells, etc.
  (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Two waste weirs both on Eastern and Western ends of the dam ; the discharging capacity of both being 13,552 cusecs
(2) Outlet works	Two cast iron pipes 12 inches diameter each, passed through masonry culverts and worked with sluice valves
(3) Scouring works	
(4) Inspection facilities	
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the dam
  (*a*) Regulation
  (*b*) Silting of the reservoir

- (*i*) Total silt deposited
- (*ii*) Rate of silting
- (*iii*) Density of the silt deposited
- (*iv*) Rate of advancement of delta

(*c*) Actual yield as against estimated.

(*d*) Various measurements and observations

- (*i*) Evaporation losses
- (*ii*) Sweating below the dam
- (*iii*) Temperature measurements
- (*iv*) Seepage and regeneration

(*e*) Fish culture

(*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

(3) Bibliography

CHAPTER IX

NARBADA BASIN

IX. 1. Jabalpur Dam

(Masonry)

I. GENERAL

(1) Height above the lowest river bed	69·0 feet
(2) Location	A stream with well-defined catchment basin in Jabalpur District, Madhya Pradesh
(3) Authority or owner	Corporation of Jubalpur City
(4) Purpose – Main and subsidiary	Water supply
(5) Year of commencement	1881
(6) Year of completion	1883 and raised by 3·75 feet in 1908
(7) Capital cost	
(*a*) Estimated	
(*b*) Actual	Rs. 2,93,908 (headworks only)
(11) Means of access	It is accessible by road and it is situated about 7 miles away on the east side of the Jabalpur city

II. GEOPHYSICAL

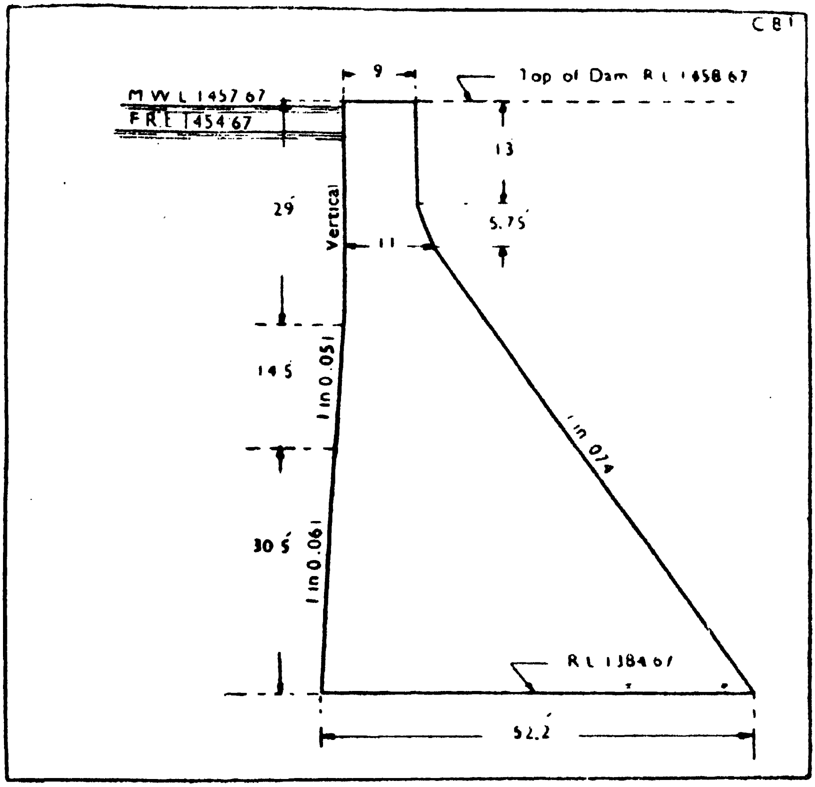
(1) Area of catchment	5·25 square miles
(2) Nature of catchment	The soil is rocky, boulders *moorum* and full of jungle
(3) Mean annual precipitation	
(*a*) Rainfall	57·33 inches
(4) Total average annual yield of the catchment	7,384 acre feet
(5) Climate	Temperate
(6) Temperature conditions and variations	Maximum temperature 116° F in shade and mean variation of 20° F

(7) Rate of flow	
(*a*) Maximum	
(*b*) Minimum	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	Clear for 8 months and carries silt for 4 months
(10) Geological features	
(*a*) of foundations	Founded on black basalt
(*b*) of catchment area	The soil is principally rocky with boulders and *moorum*

III. TECHNICAL

A. STATISTICAL

(*a*) Reservoir Data	
(*a*) M.W.L.	1457·67
(*b*) F.R.L.	R. L. 1454·67
(*c*) Area at M.W.L.	0·39 square mile
(*d*) Area at F.R.L.	0·37 square mile
(*c*) Maximum length	2 miles
(*d*) Maximum width	3/8 mile
(*g*) Length of periphery	5 ¾ miles
(2) Capacity of the reservoir	
(*a*) Gross	5,487 acre feet
(*b*) Live	5,109 acre feet
(*c*) Flood storage	603 acre feet
(*d*) Carry-over	1,265 acre feet
(3) Maximum height above the lowest point of foundations	74 feet
(4) Height above the lowest river bed at dam	69 feet
(5) Height of the top of the dam above the crest of the spillway or weir	4 feet
(6) Maximum width at level of foundation	52·2 feet
(7) Width at top	9 feet
(8) Batter of face slopes	
(*a*) Upstream (*b*) Downstream	As per cross section



Cross Section of Jabalpur dam

(9) Length at top of the dam	1,718 feet
(*a*) Non-overflow	
(*i*) Main	1,418
(*b*) Spillway	300 feet
(10) Cubic volume of the body of the dam	1,214,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Uncoursed rubble (hard black basalt laid in best hydraulic lime mortar)
(12) Specific gravity	
(*a*) Masonry	2.0
(13) Nature of protection and water-proofing of the upstream and downstream faces	Pointing
(14) Provision for dealing with and drainage water	see page

(15) Means of securing water tightness of the foundations of the dam	A trench 3 feet wide and 2 feet to 3 feet deep below the general level of foundations was filled with concrete to secure water tightness of the—foundations
(16) Contraction joints	
(17) Principal stresses in the masonry with a note of methods of calculations employed	The condition of stability was that its centre of pressure, whether reservoir full or empty, must fall within the middle third of—the wall at every level
(18) Maximum pressure on foundations	4·14 tons per square foot
(19) Uplift pressure, calculated or measured	
(20) Measures adopted for preventing or counteracting uplift pressures	

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*	
(*a*) Crown waste	0·39 square mile. The land was mostly crown waste rocky and precipitous
(*b*) Proprietory	
(2) *Dislocation*	
(*a*) Villages	
(*b*) Families	
(*c*) Population	
(*d*) Roads :	
(*i*) Highways	
(*ii*) District roads	
(*iii*) Village roads	
(*e*) Railway lines	
(*f*) Temples, mosques, *etc.*	
(*g*) Graves, *etc.*	
(*h*) Trees, gardens, pastures, houses, wells, *etc.*	Only trees and grassy land.
(*i*) Bridges	
(3) Compensation paid under each category of item (2)	
(4) Method of compensating for land of dispossessed landholders	By cash payments

V. AUXILIARY WORKS

(1) Surplussing works	The length of the waste weir is 300 feet and its discharging capacity is 18,450 cusecs with coefficient C=3·5
(2) Outlet works	Two pipes, one 16 inches diameter and the other 24 inches diameter have been provided
(3) Scouring works	
(4) Inspection facilities	A boat is maintained to inspect the bund, a tunnel is provided for inspection of the inlet tower
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	Mostly the work is done by manual labour
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurrences and accidents	
(4) Operation of the dam	A tower 18 feet in diameter and 60 feet in height has been constructed in the reservoir for the regulation of the water supply through sluice and a siphon which is fitted about 100 yards away from the main tower
(*a*) Regulation	
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated.	
(*d*) Various measurements and observations	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	

(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	Gravitational water supply like the above is very handy. It is very cheap in maintenance and does not need experts for management. Even with a small catchment area due to heavy and intense rainfall in the locality the water supply is successful.

IX. BIBLIOGRAPHY AND HISTORICAL

(i) Historical	The population of Jabalpur City and Cantonment, is 75,705 The city generally is built in a basin of granitic rock and previous to the introduction of water supply scheme, it obtained its water supply from shallow wells affording an uncertain supply not usually of good quality. In years of short rainfall many of the wells run dry, and generally the yield in such season was scanty and impure. There were in all, 1058 wells in the city proper, but of these only 187 afforded water fit for drinking In 1878 owing to short rainfall there was serious water famine. Mr. J. H. Wilsons, C. E., then Executive Engineer, Jabalpur Division had proposed two water supply schemes to the city by gravitation, out of which the proposal to construct a reservoir on the Khandari *Nala* about seven miles from the city *i.e.* the present source of water supply of Jabalpur was chosen and a scheme at a cost of Rs. 5 *lakhs* was undertaken. In cold weather of 1879 the surveys were started and by the end of 1888 the project was ready. The acutal excavation of the foundation for the masonry dam was put on hand in April 1881 and water supply was actually opened to the city in Feb. 1883, within a period of less than two years.

The extension to the above water works were attended to, the first one during 1891 and the second one during 1908. Since then there is no hardship of water supply to the city except once in 10 years when there is acute shortage of rain and water famine. During 1942, however, there was great water famine in Jabalpur owing to scanty rains and consequently very little water collection in the reservoir. The population was also very much higher than what it was originally estimated and hence supplementary water supply had to be arranged from the Pariat source.

(2) Personnel

The work was executed under the supervision of Mr. Glass, Executive Engineer and Mr. English, the Sub-Engineer in charge of the head work. Mr. St. Clair was in charge of pipe laying. The opening ceremony of the water works was done Mr. Morris, Chief Commissioner.

(3) Bibliography

Completion Report of Jabalpur Water Works, Volumes 1 to 4.

IX. 2. Jagla Dam

Earthen

I. GENERAL

(1) Height above the lowest river bed	57·0 feet
(2) Location	Balaghat District, Madhya Pradesh (Khudrai Nala)
(3) Authority or owner	Madhya Pradesh Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1910
(6) Year of completion	1916
(7) Capital cost	
(a) Estimated	
(b) Actual	Rs. 6,9360 (Head works)
(8) Culturable area commanded by the project	7,934 acres
(9) Area irrigated	1,540 acres
(11) Means of access	It is accessible by road upto Baikar from Lamtha Railway Station on Bengal Nagpur Railway

II. GEOPHYSICAL

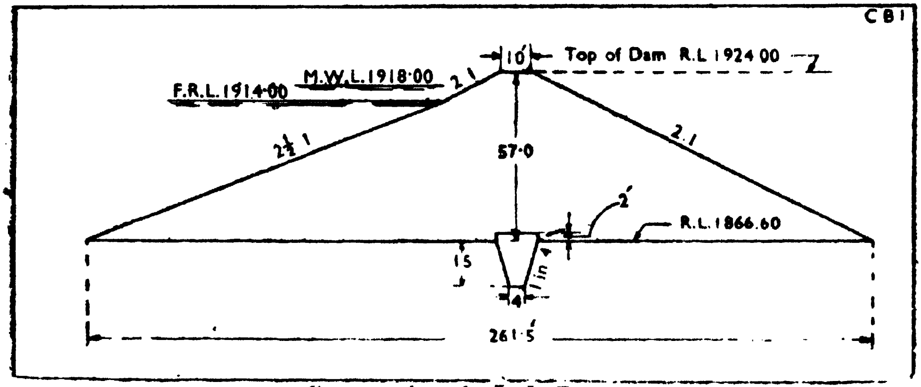
(1) Area of catchment	5 square miles
(2) Nature of catchment	Slopes vary from very steep in the hill portion to flat in cultivated portion.
(3) Mean annual precipitation	
(a) Rainfall	55·04 inches
(4) Total average annual yield of the catchment	6,947 acre feet
(5) Climate	Hot
(6) Temperature conditions and variations	There is an extreme variation in humidity

(7) Rate of flow	
(a) Maximum	
(b) Minimum	
(8) Detritus charge of the stream	Clear for 8 months and silt laden for four months
(9) Character (chemical) of the water stored in the reservoir	
(10) Geological features	
(a) of foundations	Light soil over-lying *moorum* and shale
(b) of catchment area	Light soil overlying *moorum* and shale

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(a) M.W.L	**R.L. 1918·00**
(b) F.R.L	**R.L. 1914·00**
(c) Area at M.W.L	**0·68 square mile**
(d) Area at F.R.L	0·55 square mile
(e) Maximum length	
(f) Maximum width	
(g) Length of periphery	
(2) Capacity of the reservoir	
(a) Gross	3,880 acre feet
(b) Live	3,413 acre feet (available)
(c) Flood storage	8,485 acre feet
(d) Carry-over	1,882 acre feet



Cross section of Jagla Dam

(3) Maximum height above the lowest point of foundations	72·40 feet
(4) Height above the lowest river bed at dam	57·00 feet
(5) Height of the top of the dam above the crest of the spillway or weir	10 feet
(6) Maximum width at level of foundation	261·5 feet
(7) Width at top	10 feet
(8) Slopes	
(*a*) Upstream	2 : 1 and 2½ : 1
(*b*) Downstream	2 : 1
(9) Length at top of the dam	1,040 feet
(*a*) Non-overflow	
(*i*) Main	967 feet
(*ii*) Subsidiary	
(*b*) Spillway	73 feet
(10) Cubic volume of the body of the dam	30,60,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Earth
(12) Specific gravity (*d*) Earthfill	
(13) Nature of protection and water-proofing of the upstream and down-stream faces	Pitching on upstream and 6 inches thick rubbish of rock on the down-stream
(14) Provision for dealing with seepage and drainage water	Leakage drains are provided on downstream of dam
(15) Means of securing water tightness of the foundation of the dam	By means of core-wall
(21) Hydraulic gradient for which the embankment is designed	1 : 4
(22) Particulars of the berm (if any) width and position	No berm is provided
(23) Position and form of the core-wall (or other means of securing water tightness)	As per cross section
(24) Batter (if any) of the core-wall	1 in 4 below ground level

(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	15 feet
(26) Method of keying core-wall or other wall in the underlying ground	Puddle trench core-wall
(27) Nature of material forming the core or other wall	Puddle

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
- (*a*) Crown waste
- (*b*) Proprietory

(2) *Dislocation*
- (*a*) Villages
- (*b*) Families
- (*c*) Population
- (*d*) Roads
  - (*i*) Highways
  - (*ii*) District roads
  - (*iii*) Village roads
- (*e*) Railway lines
- (*f*) Temples, mosques, *etc.*
- (*g*) Graves, *etc.*
- (*h*) Trees, gardens, pastures, houses, wells, *etc.*
- (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Drowned weir 73 feet long, with a discharging capacity of 1,613 cusecs
(2) Outlet works	Sluice gate of iron shutter type
(3) Scouring works	
(4) Inspection facilities	Sluice tower and tunnel under embankment accessible for inspection
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	One foot thick stone pitching is provided on the bed and slopes of spill channel

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurrences and accidents	
(4) Operation of the dam	
(a) Regulation	By means of iron sluice gates of shutter type
(b) Silting of the reservoir	
(i) Total silt deposited	
(ii) Rate of silting	
(iii) Density of the silt deposited	
(iv) Rate of advancement of delta	
(c) Actual yield as against estimated	Actual yield is 225·6 million cubic feet against estimated, 203·6 million cubic feet
(d) Various measurements and observations	
(i) Evaporation losses	
(ii) Sweating below the dam	
(iii) Temperature measurements	
(iv) Seepage and regeneration	
(e) Fish culture	
(f) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

(3) Bibliography

IX. 3. Pariat Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	74·6 feet
(2) Location	Jabalpur District, Madhya Pradesh
(3) Authority or owner	Madhya Pradesh Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1917
(6) Year of completion	1927
(7) Capital cost	
(a) Estimated (as per 3rd revised estimate)	Rs. 19,63,439
(b) Actual	Head Works Rs. 780532 } Channels Rs. 330507 } Rs. 11,11,039
(8) Culturable areas commanded by the project	6,170 acres
(9) Area irrigated (*Kharif*)	Average of 10 years from 1940-41 to 1949-50—Kharif 336 acres
(11) Means of access	It is accessible from Jabalpur railway station by pacca road, 14⅝ miles distant along Jabalpur Kundam Dindori Road

III. GEOPHYSICAL

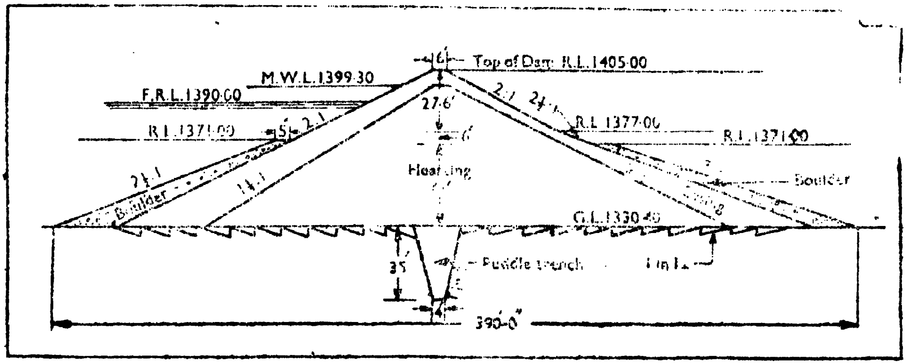
(1) Area of catchment	42 square miles
(2) Nature of catchment	
(3) Mean annual precipitation	
(a) Rainfall	52·09 inches
(4) Total average annual yield of the catchment	82,485 acre feet
(5) Climate	Temperate
(6) Temperature conditions and variations	Maximum temperature 116°F with variation of 20°F mean

(7) Rate of flow	
(*a*) Maximum	33,000 cusecs
(*b*) Minimum	
(8) Detritus charge of the stream	Clean for 8 months and silt laden for 4 months during rainy season
(9) Character (chemical) of the water stored in the reservoir	
(10) Geological features	
(*a*) of foundations	Foundation has been taken down to a depth of 35 feet below G. L. and met with the following strata—Black yellow sandy earth, Boulders and sand, *etc.*
(*b*) of catchment area	Trap rock at higher levels overlying Lamita formation in valley, bottom Slopes Fairly steep
(11) Earthquake (zone and intensities)	

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M.W.L.	R.L. 1399·30
(*b*) F.R.L.	R.L. 1390·00
(*c*) Area at M.W.L.	
(*d*) Waterspread Area at F.R.L	1·31 square miles
(*e*) Maximum length	2-1/12 miles
(*f*) Maximum width	7/12 miles
(*g*) Length of periphery	6·6 miles
(2) Capacity of the reservoir	
(*a*) Gross	16,263 acre feet
(*b*) Live	15,005 acre feet
(*c*) Flood storage	8,627 acre feet
(*d*) Carry-over	5,002 acre feet
(3) Maximum height above the lowest point of foundations.	109·6 feet
(4) Height above the lowest river bed at dam	74·6 feet
(5) Height of the top of the dam above the crest of the spillway or weir	15 feet



Cross Section of Pariat Dam

(6) Maximum width at level of foundation	390 feet
(7) Width at top	6 feet
(8) Slopes	
(a) Upstream	2 : 1 and 2½ : 1
(b) Downstream	2 : 1 and 2·5 and 3 : 1
(9) Length at top of the dam	3,875 feet
(a) Non overflow	
(i) Main	3,549 feet
(ii) Subsidiary	
(b) Spillway	326 feet
(10) Cubic volume of the body of the dam	15 000,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	The embankment comprises a hearting consisting mainly of yellow clay and casing of *moorum*, pebbles and soft rock is provided on both the upstream and downstream slopes. The embankment is strengthened by the addition of a 5 ft. berm at R.L. 1371 on both upstream and downstream sides.
(12) Specific gravity	
(c) Rockfill	
(d) Earthfill	

(13) Nature of protection and water proofing of the upstream and downstream faces	Dry stone pitching 1 foot thick on upstream side only. A 6" soiling of quarry spawls has been provided under the pitching wherever the casing was not considered sufficiently good.
(14) Provision of dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundation of the dam	By means of puddle core-wall
(22) Particulars of the berm (if any) width and position	5 feet wide berm on both upstream and downstream sides at R.L. 1371·00
(23) Position and form of the core-wall (or other means of securing water tightness)	As per sketch
(24) Batter (if any) of the core-wall	1 in 4
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	35 feet
(26) Method of keying core-wall or other wall in the underlying ground	Puddle trench core-wall
(27) Nature of material forming the core or other wall	Clayey puddle

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*	
(*a*) Crown waste	
(*b*) Proprietory	
(2) *Dislocation*	
(*a*) Villages	3 villages (Mehgwan, Dharhar and Bijapur)
(*b*) Families	
(*c*) Population	
(*d*) Roads	
(*i*) Highways	
(*ii*) District roads	
(*iii*) Village roads	
(*e*) Railway lines	
(*f*) Temples, mosques, *etc.*	

(g) Graves, etc.	
(h) Trees, gardens, pastures, houses, wells, *etc.*	
(i) Bridges	
(3) Compensation paid under each category of item (2)	
(4) Method of compensating for land of dispossessed landholders	Cash payment

V. AUXILIARY WORKS

(1) Surplussing works	Length of waste weir 326 feet, its discharging capacity is 33,000 cusecs with " C "-3·25.
(2) Outlet works	The sluice is fitted with a penstock gate, 3·5 feet × 3 feet.
(3) Scouring works	
(4) Inspection facilities	Sluice tower and tunnel under embankment accessible for inspection.
(5) Fish-pass	
(6) Means for dissipating energy below the spillway.	By means of 3 falls

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	Mostly the work was done by manual labour with mechanical transport for materials
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	Flood lift increased from 5 feet to 9·3 feet and the top of the dam raised accordingly
(3) Noteworthy occurrences and accidents	Waste weir and spill channel were damaged by the severe flood that occurred in July 20/21, 1930. No accident took place
(4) Operation of the dam	
(a) Regulation	By means of a sluice gate with lifting arrangements at the sluice tower and a gauge fixed
(b) Silting of the reservoir	
(i) Total silt deposited	
(ii) Rate of silting	
(iii) Density of the silt deposited	
(iv) Rate of advancement of delta	
(c) Actual yield as against estimated	
(d) Various measurements and observations	
(i) Evaporation losses	
(ii) Sweating below the dam	

(*iii*) **Temperature measurements**
(*iv*) **Seepage and regeneration**
(*e*) **Fish culture**
(*f*) Anti-malaria measures
(5) Recreation facilities — A boat is maintained.
(6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) **Historical**

The scheme was first investigated in 1914 under the direction of Mr. R. H. Tickell, Chief Engineer. An estimate for the works amounting to Rs. 5.79,781 for works only and to Rs. 7.82.688 including all charges was submitted on the 5th July 1915 to the Government of India and was sanctioned by the latter in their letter No. 952-I dated the 9th September 1915. This estimate provided for a tank with a catchment area 685 square miles and an irrigable capacity of 1,734 M. cft. to irrigate 7.100 acres of *kharif*. 7.100 acres of *rabi* and 900 acres of cane in a normal year. It was proposed to feed the Jabalpur, Panagarh, Mohari and Barera-Kalan tanks and to render irrigation from them more efficient. The project was highly recommended by the revenue and agricultural officers of the district. The deputy commissioner remarked that income would be derived from irrigation proper in addition to indirect revenue derived from the extension of cultivation to fallow land and to the gradual extention of the necessity for suspension and remission of revenue. He stated that "It is impossible to frame even an approximate estimate of the income from irrigation as such but it seems clear that in the next few years at any rate it would be large." The commissioner stated that "The first need of the district is irrigation.

The present scarcity has given a great impetus to the construction of useful tank and it is possible now to look forw ard to the time when the greater part of the district will be insured against serious famine". He remarked that the statement attached to the Deputy Commissioner's note which shows that in seven years out of the last twenty the crops have suffered from deficient or untimely rainfall, provides in my opinion ample justification for pursuing on the construction of the Pariat Pala scheme. The Financial Commissioner stated that the scheme would have a high protective value and financially it was not without promise. In forwarding the project estimate to the Government of India it was stated that " the Chief Commissioner considers the work to be so important and of such high protective value that, the Government of India approve of the project, he would like to see it started atonce.

It was estimated that a net return of 5·2 percent in the total cost of the work would be obtained but, including the cost of the Jabalpur, Panagarh, Mohari and Barera Kalan schemes, a return of 3·6 percent was expected and the work was therefore sanctioned as a protective and not as a productive work.

While arrangements were being made to start construction, it became apparent that the cost of the project had been very much underestimated, that the proposed capacity of the tank was unnecessarily large and that a more favourable site for the tank existed about 3½ miles upstream of the original site. A revised estimate amounting to Rs. 5,94,178 for new works only and to Rs. 8,88,766 including all charges was submitted by the Local Government with their letter No. C.94 dated the 5th May 1917 to the Government of India and was sanctioned by the latter in their letter No. 395-I dated the 11th June 1917. This estimate included a sum of Rs. 1,24,500 which had been spent on the construction of the Jabalpur and Panagarh tanks and on the portion of the Barera Kalan Channels which were to be incorporated in the scheme. The estimate provided for a tank with a catchment area of 42 square miles and an irrigable capacity of 690·4 m.cft. to irrigate 4,000 acres of *kharif*, 2,800 acres of *rabi* 1,000 acres of thin cane and 200 acres of thick cane 8,000 acres in all. A return of 3·4 percent was expected, construction of head works was started in October 1917 and work on the main channel and Left bank channel was commenced in 1918.

3. A second revised estimate for the work was prepared early in 1922 mainly because the rates for works had increased enormously since the war and partly because it was considered necessary to raise the height of the embankment by 2 feet to provide additional freeboard. This estimate amounting to Rs. 9,97,743 for works only and to Rs. 14,90,876 including all charges was sanctioned by the Local Government in their letter No. 143 C. W. I. dated the 4th October 1922. It included a sum of Rs. 1,16,190 which had been spent on the construction of Jabalpur and Panagarh tanks. No provision was made for feeding the Barera Kalan Channel and it was decided that the combined Mohari-Barera Kalan scheme should be treated as a separate project. A revised

financial forecast was prepared and a return of 2·73 percent was expected. The deputy Commissioner stated that there could be no risk in assuring that the areas of irrigation forecasted would be obtained soon and without difficulty.

Construction of a right bank channel was started in 1925.

A third revised estimate was submitted in March 1925 and was sanctioned by the Local Government in their letter No. 89-B.W.I. dated 16th September 1926. This estimate amounted to Rs. 12,08,556 for works only and Rs. 1,93,439 including all charges and it included a sum of Rs. 81,134 spent on the construction of Jabalpur tank. It was decided to abandon the proposal to feed Panagarh tank and provision for the cost of construction of this tank was therefore not made in the estimate. The third revised estimate was necessitated mainly by the additional work on the head works found necessary as a result of exceptionally heavy floods, the height of the embankment had again been raised by 2 feet after an abnormal flood in August 1923 and expensive masonry falls in the spill channel were provided. It was also partly due to the fact that the cost of the work had been underestimated. The areas to be irrigated from the combined Pariat and Jabalpur tanks were refixed at 2,100 acres of *kharif* 1,000 acres of *rabi*, 700 acres of cane and 200 acres of garden and fodder crops and a revised financial forecast, based on these areas, was prepared according to which a return of 1·52 percent was expected.

5. The construction estimate was closed on the 31st March 1927 and subsequently the Pariat and Jabal-

pur tanks have under the orders of the Local Government, been treated as one work, with effect from the 1st April 1927, the cost of maintenance and repair of the Jabalpur tank has been debited and the revenue of that tank credited to the Parait tank and the cost of Jabalpur tank has been brought on to the administrative accounts of the Parait tank for the year 1927-28.

6. A list of the names of the officers who have been responsible for the construction of the work is attached to this report.

(2) *Personnel*

1. Mr. E. L. Glass, Executive Engineer.
2. Mr. F. W. McCall, Temporary Engineer.
3. Mr. Milkiram Chopra, Temporary Engineer.
4. Mr. Bhakt Narain, Temporary Engineer.
5. Mr. F. W. McCall, Temporary Engineer.
6. Mr. W. C. N. Shilstone, Executive Engineer.
7. Mr. C. Q. Henriques, Executive Engineer.
8. Mr. W. C. Rose, Temporary Engineer.
9. Mr. K. L. Jhanjee, Executive Engineer.
10. Capt. F. A. Eustace, Officiating Ex-Engineer.
11. Mr. G. H. Forest, Executive Engineer.
12. Mr. G. S. Duncan, Officiating Ex-Engineer.
13. Mr. Abdul Wahid, Assistant Executive Engineer.
14. Mr. L. N. Agarwal, Assistant Executive Engineer.
15. Mr. J. S. Duncun, Assistant Executive Engineer.
16. Mr. B. B. Gupta, Assistant Engineer.

(3) *Bibliography*

IX. 4. Bahoribund Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	73·0 feet
(2) Location	Jabalpur District, Madhya Pradesh,
(3) Authority or owner	Madhya Pradesh Government
(4) Purpose-Main and Subsidiary	Irrigation
(5) Year of commencement	1917
(6) Year of completion	1929
(7) Capital cost	
(*a*) Estimated	Rs. 13,27,000
(*b*) Actual	Rs. 13,04,790
(8) Culturable area commanded by the project	15,817 acres
(9) Area irrigated	2,246 acres
(11) Means of access	It is accessible from Sihora Town situated at mile 26 from Habalpur on Sabalpur-Mirzapur road and thence by Sihora Salenga road that bifurcates from mile 29 of J. M. Road which passes along at a distance of about three miles from dam site. Total 17 miles north of Sihora town

II. GEOPHYSICAL

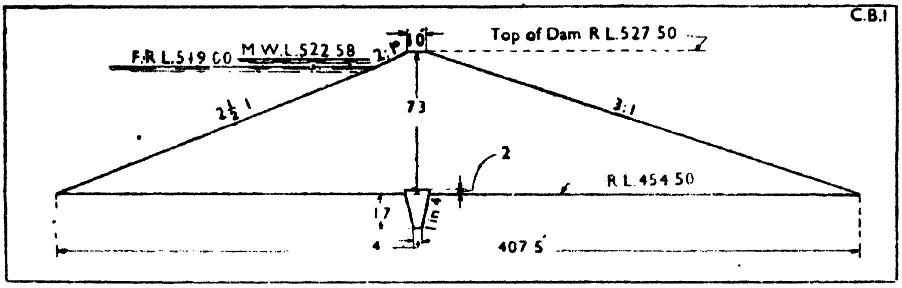
(1) Area of catchment	42 square miles
(2) Nature of catchment	Vindhyan sand stone, Slopes not steep
(3) Mean annual precipitation	
(*a*) Rainfall	46·04 inches
(4) Total average annual yield of the catchment	37,236 acre feet
(5) Clima	Temperate
(6) Temperature conditions and variations	Maximum temperature 116 F variations 20° F (mean)

(7) Rate of flow	
(*a*) Maximum	
(*b*) Minimum	
(8) Detritus charge of the stream	Sand and silt
(9) Character (chemical) of the water stored in the reservoir	
(10) Geological features	
(*a*) of foundations	Vindhyan sand stone met with 17 feet below ground level composed of Petarwa and Sehra soils, Domatte and Bhatwa
(*b*) of catchment area	

III. TECHNICAL

A. STATISTICAL

(1) Reservior Data	
(*a*) M.W.L.	R.L. 522·5
(*b*) F.R.L.	R.L. 519·00
(*c*) Area at M.W.L.	
(*d*) Area at F.R.L.	3·77 square miles
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of preiphery	
(2) Capacity of the reservoir	
(*a*) Gross	29,970 acre feet
(*b*) Live	27,972 acre feet
(*c*) Flood storage	
(*d*) Carry over	9,318 acre feet



Cross Section of Bahoribund Dam

(3) Maximum height above the lowest point of foundations	90 feet
(4) Height above the lowest river bed at dam	73 feet

(5) Height of the top of the dam above the crest of the spillway or weir	8·5 feet
(6) Maximum width at level of foundations	407·5 feet
(7) Width at top	7 feet, 8 feet and 10 feet
(8) Slopes	
(*a*) Upstream	2 : 1 and 2½ : 1
(*b*) Downstream	3 : 1, 2 : 1 and 5 : 2
(9) Length at top of the dam	5,813 feet
(*a*) Main	3,400 feet
(*b*) Spillway	613 feet
(10) Cubic volume of the body of the dam	5,540,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Fairly light clay
(12) Specific gravity	
(*d*) Earthfill	
(13) Nature of protection and water proofing of the upstream and downstream faces	Dry stone pitching 1·0 foot thick on upstream slope only. Downstream face grassed.
(14) Provision for dealing with seepage and drainage water.	Catchwater and seepage drains
(15) Means of securing water tightness of the foundations of the dam	By means of puddle core-wall
(21) Hydraulic gradient for which the embankment is designed	1 : 4
(22) Particulars of the berm (if any) width and position	
(23) Position and form of the core-wall (or other means of securing water tightness)	As per cross section
(24) Batter (if any) of the core-wall	1 in 4
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	17 feet
(26) Method of keying core-wall or other wall in the underlying ground	Puddle trench core-wall
(27) Nature of material forming the core or other wall	Clay-puddle

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) Land submerged	
(*a*) Crown waste	
(*b*) Proprietory	
(2) Dislocation	
(*a*) Villages	
(*b*) Families	
(*c*) Population	
(*d*) Roads	
(*i*) Highways	
(*ii*) District roads	
(*iii*) Village roads	
(*e*) Railway lines	
(*f*) Temples, mosques, *etc.*	
(*g*) Graves, *etc.*	
(*h*) Trees, gardens, pastures, houses, wells, *etc.*	
(*i*) Bridges	
(3) Compensation paid under each category of item (2)	
(4) Method of compensating for land of dispossessed landholders	By cash payment

V. AUXILIARY WORKS

(1) Surplussing works	Length of waste weir is 613 feet, its discharging capacity 13,065 cusecs with " C " = 3·25
(2) Outlet works	Right bank sluice vent 2·5 feet by 2·5 feet. Left bank sluice vent 3·25 feet by 3·25 feet
(3) Scouring works	
(4) Inspection facilities	
(5) Fish pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	Mostly the work was done with manual labour and mechanical transport.
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	

(3) Noteworthy occurrences and accidents	The influenza epidemic of 1918 considerably hampered the work with the result that the labour had to be imported and thereby the cost of work subsequently increased
(4) Inspection facilities	Sluice tower and tunnel under embankment accessible for inspection
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	
(4) Operation of the dam	
(a) Regulation	By means of two sluices
(b) Silting of the reservoir	
(i) Total silt deposited	
(ii) Rate of silting	
(iii) Density of the silt deposited	
(iv) Rate of advancement of delta	
(c) Actual yield as against estimated	1,622·5 million cubic feet against 1,738·7 million cubic feet estimated
(d) Various measurements and observations	
(i) Evaporation losses	258 million cubic feet
(ii) Sweating below the dam	
(iii) Temperature measurements	
(iv) Seepage and regeneration	
(e) Fish culture	
(f) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	

IX. BIBLIOGRAPHY AND HISTORICAL

(1) *Historical*	Bahoribund Tank is situated in the Sehara Tehsil of Jabalpur District about 17 miles north of Sehara town. It is approached by the Sehara-Salaiya road and the Steemanabad Bahoribund road It irrigates on both sides of the Sohar *nala* running south-west from the tank

In 1913 Benjamin Robertson Chief Commissioner, drew attention to the necessity of an irrigation work to protect the Sohar Valley in the vicinity of Bahoribund. This area had suffered severely in the then recent famines and scarcities, and gratuitous relief was said to have been granted in it on a larger scale than in any of the other revenue circles of the Jabalpur District. The investigation was undertaken by Mr. W. N. Shilstone, Executive Engineer, Narmada Division who in 1915 submitted a project for a tank with an irrigable capacity of 576 million cubic feet. The site of the tank was the same as finally adopted, but it was proposed to construct a masonry dam instead of an earth embankment. The cost of the scheme was estimated at Rs. 3·25 *lakhs* by the Superintending Engineer (Mr. Beddy), who proposed to irrigate 8,500 acres of rice, 850 acres of *rabi* and 450 acres of cane

The estimate was not approved. The Chief Engineer (Mr. Tickell) decided that the work must be regarded as a major work. An estimate of Rs. 2,973 for its investigation was submitted to the Government of India in August 1915, and was sanctioned in September of that year. Meanwhile orders were issued that the work should be investigated for a capacity of 895 million cubic feet with a view to irrigate 50 acres of cane, 3,280 acres of *kharif* and 6,560 acres of *rabi*. The duty at the sluice for kharif was fixed at 80 acres per cusec and for *rabi* at 120 acres per cusec. In forwarding the original project, submitted by (Mr. Shilstone), the Deputy Commissioner Jabalpur (Mr. Maw) remarked as follows :—

"The area commanded includes 22 villages of the Bahoribund circle and

19 of the Majhali circle. But all the villages are below the plateau which constitutes the greater part of the Bahoribund circle ; the cultivation is more *rabi* than *kharif* and from the point of view of previous famines the whole of the area commanded may be regarded as forming a part of the Majholi circle. The past history of this tract has not been so unfortunate as that of the Bahoribund, Salaiya and Rathi tracts, where rice and kodon predominate, but nevertheless distress arising from insufficient rainfall has been common of recent years and there is no doubt that the thorough protection of a large area in the Majholi Circle is an object on which the Government money could be most usefully expended. The villages commanded contain a large area of Sehra and Domatta soils which are suitable for irrigation. Detailed enquiries have been made as to the willingness of the people to pay for water and, as is usually the case when the payment of water rates is first raised, the cultivators were alarmed at the idea of payment of an amount equal to or exceeding their rents. It may, however, be assumed from the experience at *Khitile* and other places that water will be taken eargerly even at the rate of Rs. 3 an acre in years of deficient rainfall. I agree with Mr. Shilstone that the project is a very favourable one. I do not believe that for some time, the cultivators would take, much water for their *kharif* crops in a year of normal rainfall. There are however, in nearly every year, times when water is required and I think there will frequently be a demand for water to facilitate the sowing of the *rabi* crops or to give the soil the necessary moisture in years like the

present in which there are no Christmas rains. The *kharif* area amounts to 5,361 acres (compared with 7,650 acres proposed to be irrigated by the Executive Engineer) for which only 20 acres are irrigated at present, and with the completion of the tank there can be little doubt that the area under rice will increase considerably. The estimate of the area of *rabi* to be irrigated in a normal year (850 acres) is, I think a very safe one. But there is practically no sugar cane at present in the area commanded and it will take many years before the cultivator will be able to work up to the estimated figure of 450 acres. I am of opinion that the present investigation is quite sufficient to justify the preparation of the project in stage II. Even if this was not the case, the fact, that promising projects to complete the famine programme would fully justify the completion of tne plans and estimate "

The commissioner (Mr. A. B. Napier) stated that though he had no personal knowledge of the area commanded, he had on the reports of the Executive Engineer and Deputy Commissioner no hesitation in recommending the further investigation of the scheme. He remarked " The statistics given show that there is every hope of the project being financially successful, though the Deputy Commissioner is prudent in painting out that its full revenue will take some time to reach. It is most necessary that a new work should be got ready for the famine programme in this part of the district and this work, even if further investigation shows that its chances of becoming productive are smaller than at present seems probable, will have a high protective value

Further investigation was then taken and the site was inspected by the Chief Engineer (Mr. Wadley). A second estimate was submitted in September, 1916 by Mr. E. L. Glass, Executive Engineer, Narmada Division

In this estimate provision was made for three reservoirs on the Sohar Kuan and Kair *nalas.* The cost of the work was estimated at Rs. 7·50 *lakhs* for works and intended to irrigate 13,800 acres of *kharif* and 9,200 acres in 108 villages. Meantime the area under command had been examined by M/S Wilson and Evans D. C. Jabalpur, and Deputy Director of Agriculture Northen Circle, respectively, who had submitted a joint report on its revenue and agricultural conditions. They stated that while the soil at the head of the valley was light and required irrigation, that at the lower end was heavily embanked and the *rabi* crop on it suffered more from an excess than from a deficiency of water. They recommended that only the Bahoribund reservoir on the Sohar nala should be constructed and that irrigation should be confined to the light soil in the upper portions of the valley. These recommendations were accepted by Government and approval was accorded to the investigation of a scheme on the Sohar *nala* with a capacity of 1,016 million cubic feet for the irrigation of area under command of 16,000 acres. At the same time sanction was accorded to the commencement of work on the dam of the Bahoribund reservoir, the cost of which (work charges only) had been estimated in detail at Rs. 1,25,142.

Work was started on the construction of the head work, but considerale delay occurred in the preparation of plans and estimates for the channels

In February 1920, it was reported that the cost of the headwork would be Rs. 2·53 *lakhs* (works only) or double the amount previously sanctioned. The reasons for this increase were stated to be :—

(*a*) Insufficient levels had been taken in the bed of the tank, the area to be acquired had been found to be 2,328 acres compared wih 1,644 acres as originally expected

(*b*) The rate provided for land acquisition (Rs. 12/8/- per acre) was found to be insufficient and had to be increased to Rs. 32/4/-

(*c*) The rate for earth work in the dam was increased from Rs. 10 to Rs. 13/14/- per thousand cubic feet and this increase combined with an increase of the cost of earth work from Rs. 79,905 to Rs, 1,41, 049

In March 1921 an abstract estimate amounting to Rs. 2·19 *lakhs* for works and Rs. 2·81 *lakhs* inclusive of all charges was sanctioned for the construction of the left bank channel and in April 1922 a similar estimate amounting to Rs. 0·91 *lakhs* (works-only) and Rs. 1·18 *lakhs* inclusive of all charges was sanctioned for the construction of the right bank channel.

The estimate for the headworks was again received in January 1924 when a work slip was sanctioned for Rs. 3·41 *lakhs*. Inquiry showed that the work had been carried out under difficult conditions. It was started, on what was undoubtedly a most inadequate estimate, in unsatisfactory manner. The main *nala* was closed during the first year of construction and this caused considerable difficulty in the subsequent work. Increase of rates due to the war and influenza epidemic of 1918-19 caused further trouble and an excess over the sanctioned estimate was inevitable. In spite of all difficulties the headworks are one of the cheapest constructed in the State ; the eventual cost being Rs. 3·481 *lakhs* or Rs. 285 per million cubic feet of water available for irrigation compared with Rs. 311 in the case of the Ramtek reservoir, Rs. 481 of Chorkhamara and Rs. 839 of the Sarathi reservoir

During 1924 a revised estimate for the whole work was sanctioned ; the amount being Rs. 7·57 *lakhs* for works only and Rs. 12·06 *lakhs* inclusive of all charges. At the time this estimate was sanctioned the headworks and the right bank channel had been practically completed, but the construction of the left bank channel had only just been started. The construction of thisch annel which involved considerable lengths of heavy earthwork for which labour had to be imported, proved to be more expensive than had originally been anticipated and in 1928 a second revised estimate amounting to Rs. 8·50 *lakhs* for works and Rs. 13·27 *lakhs* inclusive of all charges was sanctioned

Mr. E. L. Glass
Mr. F. W. Mc Call
Mr. Milkiram Chopra
Mr. Bhakt Narain

(2) Bibliography

Mr. W. C. N. Shilstone
Mr. C. Q. Henriques
Mr. W. C. Rose
Mr. K. L. Jhanji
Captain F. A. Eustace
Mr. G. H. Forest
Mr. J .S. Duncan
Mr. B. B. Gupta
Mr. G. A. D. Cochrane

CHAPTER X

GANGA BASIN

X-1. Paricha Dam

(Masonry)

I. GENERAL

(1) Height above the lowest river bed	53 feet
(2) Location	Jhansi district Uttar Pradesh (Betwa river)
(3) Authority or owner	Uttar Pradesh Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1881
(6) Year of completion	1885
(7) Capital cost	
(a) Estimated	Rs. 44,83,776
(b) Actual	Rs. 41,80,671 + 1,90,586 (Works) (Shutters)
Total	Rs. 43,71,251
(8) Culturable area commanded by the project	1,011,300 acres
(9) Area irrigated	180,000 acres
(11) Means of access	(a) It is accessible from Jhansi, 14 miles along the Provincial road from Jhansi to Lucknow and then a mile due south along the canal road. (b) It is three miles distant from Paricha Railway Station on the Jhansi-Kanpur branch (Great Indian Peninsular Rly.)

II. GEOPHYSICAL

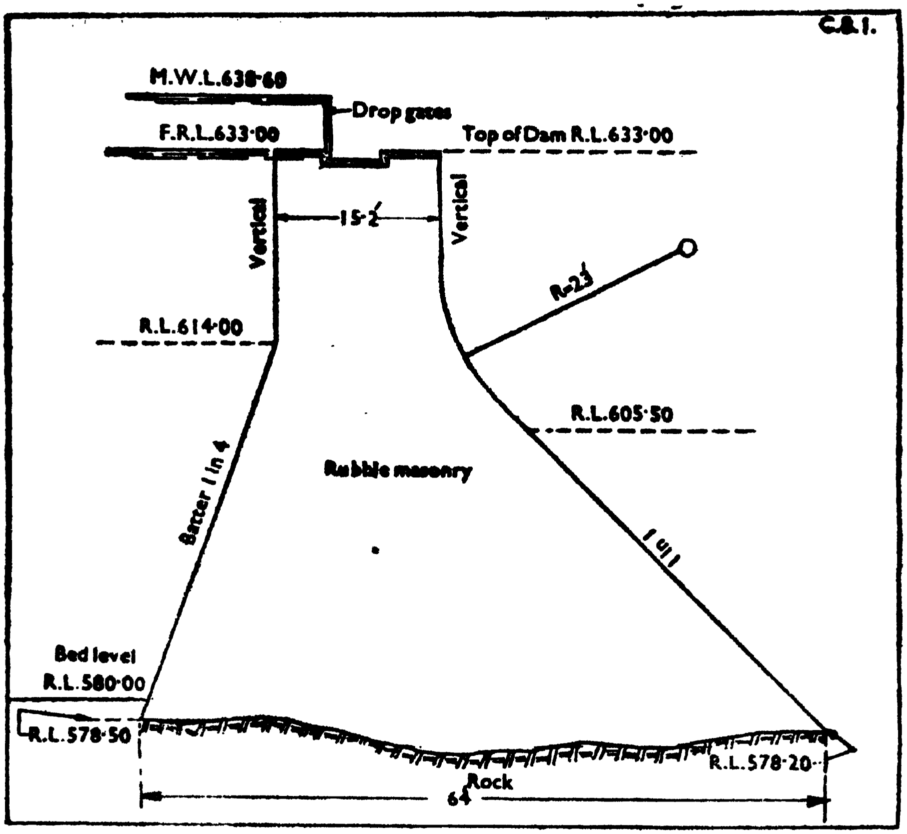
(1) Area of catchment	10,384 square miles
(2) Nature of catchment	The catchment is hilly with some cultivation.

(3) Mean annual precipitation	
(a) Rainfall	**36 inches**
(4) Total average annual yield of the catchment	**4,589,950 acre feet**
(5) Climate	**Sub-Tropical**
(6) Temperature conditions and variations	**Maximum temperature 115° F** **Minimum temperature 40°F**
(7) Rate of Flow	
(a) Maximum	**1,000,000 cusecs**
(b) Minimum	**No flow**
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	**Clear except in flood season**
(10) Geological features	
(a) of foundations	**Hard rock**
(b) of catchment area	**Partly rocky and partly flat with vegetation**
(11) Earthquake (zone and intensities)	**The earthquake of January 1934 caused a few fine cracks in the weir**

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(a) M. W. L.	**R. L. 638·60**
(b) F. R. L.	**R. L. 633·00**
(c) Area at M. W. L.	**3·5 square miles**
(d) Area at F. R. L.	-
(e) Maximum length	
(f) Maximum width	
(g) Length of periphery	
(2) Capacity of the reservoir	
(a) Gross	**74,105 acre feet**
(b) Live	**67,723 acre feet**



Cross Section of Paricha Dam

(3) Maximum height above the lowest point of foundations	**54·8 feet**
(4) Height above the lowest river bed at dam	**53 feet**
(5) Height of the top of the dam, above the crest of the spillway or weir	**Top of dam acts as spillway and drop gates of 5·6 feet height installed on top of the dam.**
(6) Maximum width at level of the foundation	**64 feet**
(7) Width at top	**15·2 feet**
(8) Batter of face slopes	
(*a*) Upstream	**1 : 4 and vertical**
(*b*) Downstream	**1 : 1 and vertical**

(9) Length at top of the dam	
(*a*) Non over flow	3,853 feet
(i) Main	The whole top length of the dam serves as spillway.
(*b*) Spillway or weir	3,853 feet
(10) Cubic volume of the body of the dam	

B. OTHERS

(11) Material of which the dam is constructed	Random rubble masonry in *kankar* lime
(12) Specific gravity	
(*a*) Masonry	2·24
(13) Nature of protection and water proofing of the upstream and down stream faces	Cement pointing
(14) Provision for dealing with seepage and drainage water	The seepage goes right in the river bed downstream
(15) Means of securing water tightness of the foundations of the dam	It is a masonry dam and designed for tightness as well
(16) Contraction joints	
(17) Principal stresses in the masonry with a note of methods of calculations employed	
(18) Maximum pressure on foundations	3·84 tons per square foot
(19) Uplift pressure calculated, or measured	
(20) Measures adopted for preventing or counteracting uplift pressures	
(21) Core or other wall	

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory

(2) *Dislocation*
  (*a*) Villages
  (b) Families
  (*c*) Population
  (*d*) Roads
    (*i*) Highways
    (*ii*) District Roads
    (*iii*) Village Roads

(*e*) Railway Lines	
(*f*) Temples, Mosques, *etc.*	
(*g*) Graves, *etc.*	
(*h*) Trees, gardens, pastures, house wells, *etc.*	
(*i*) Bridges	
(3) Compensation paid under each category of item (2)	
(4) Method of compensating for land of dispossessed landholders	Land was acquired under Government Notification, and paid for according to rates in force at the time, the rate being allowed Rs. 200 per acre.

V. AUXILIARY WORKS

(1) Surplussing works	The total length of the dam acts as a spillway 3,852 feet and its maximum discharging capacity is 750, 000 cusecs. In addition to this four river sluices are also provided and can discharge 10,000 cusecs.
(2) Outlet works	
(3) Scouring sluices	
(4) Inspection facilities	All works could only be inspected when the dam is empty
(5) Fish pass	Fish ladder is provided
(6) Means for dissipating energy below the spillway	A sub-weir all-along the length of the masonry dam has been provided. Maximum width being 10-12 feet.

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	All work was done by manual labour.
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurrences and accidents	
(4) Operation of the dam	
(*a*) Regulation	
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	

(*c*) Actual yield as against estimated	
(*d*) Various measurements and observations	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	Dam is auctioned for fishing every year.
(*f*) Anti-malaria measures	
(5) Recreation facilities	A motor Boat exists at site.
(6) Lessons to be learnt from the construction and utilisation of the dam	A low dam built with the river upstream flowing in a deep gorge ensures the reservoir against loss of storage capacity by silting.

IX. BIBLIOGRAPHY AND HISTORICAL

1. Historical	The project was initiated by Captain Strachey in 1885. Later on Lt. Home Royal Engineer, took the scheme in hand and started with its surveys and detailed investigations. After the investigations and surveys were completed scheme was got sanctioned from the Government. Mr. P. W. Nuder Horst was made incharge of the construction and the completed the scheme.
2. Personnel	Mr. P. W. Nuder Horst.
3. Bibliography.	

X-2. Dhukwan Dam

I. GENERAL

(1) Height above the lowest river bed	46·45 feet
(2) Location	Jhansi District, Uttar Pradesh (Betwa River)
(3) Authority or owner	Uttar Pradesh Government
(4) Purpose Main and subsidiary	Irrigation
(5) Year of commencement	1904
(6) Year of completion	1909
(7) Capital cost	
(a) Estimated	
(b) Actual	
(8) Culturable area commanded by the project	
(9) Area irrigated	
(11) Means of access	

II. GEOPHYSICAL

(1) Area of catchment	8,240 square miles
(2) Nature of catchment	Hilly
(3) Mean annual precipitation	
(a) Rainfall	36 inches
(4) Total average annual yield of the catchment	3,673,073 acre feet
(5) Climate	Sub Tropical
(6) Temperature conditions and variations	Maximum temperature 115°F Minimum temperature 40°F
(7) Rate of Flow	
(a) Maximum	556,000 cusecs
(b) Minimum	No flow
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	
(10) Geological features	
(a) of foundations	Hard rock
(b) of catchment area	Hilly catchment
(11) Earthquake (Zone and intensities)	

X. 2. (ii)

III. TECHNICAL

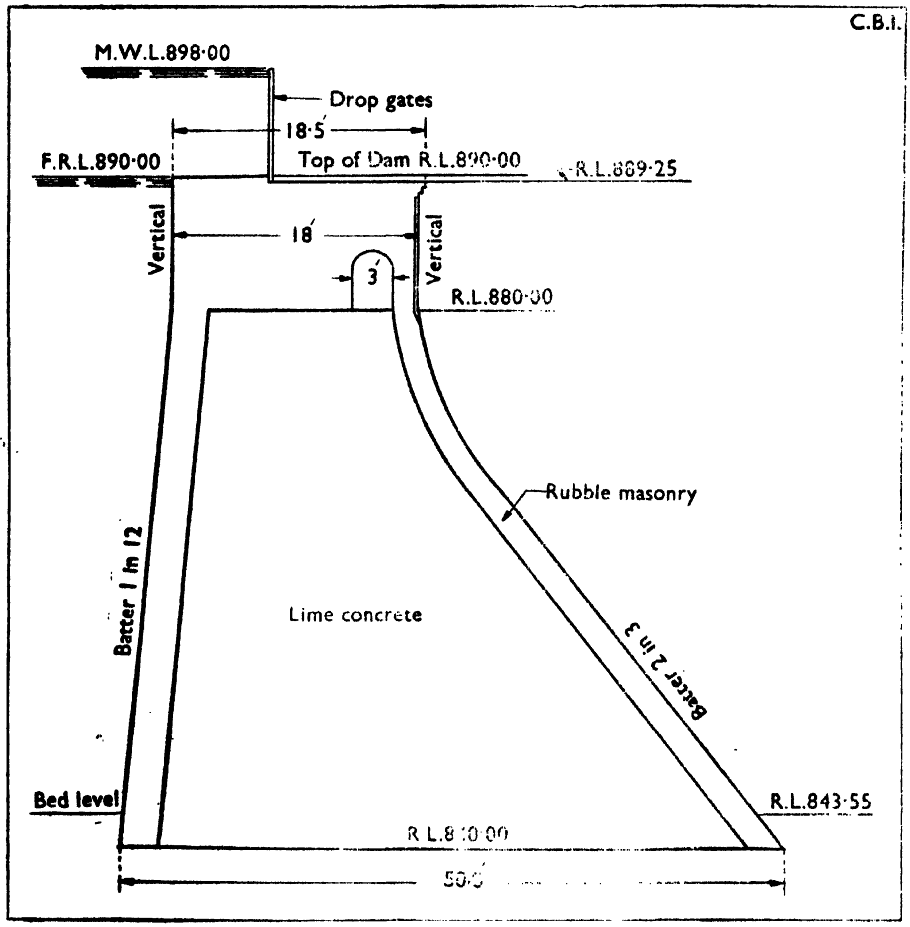
A. STATISTICAL

(1) Reservoir Data

(*a*) M. W. L.	R. L. 898·00
(*b*) F. R. L.	R. L. 890·00
(*c*) Area at M. W. L.	7·5 square miles
(*d*) Area at F. R. L.	
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	

(2) Capacity of the reservoir

(*a*) Gross	
(*b*) Live	36,295 acre feet
(*c*) Flood storage	
(*d*) Carry-over	



Cross Section of Dhukwan Dam

(3) Maximum height above the lowest point of foundations	50 feet
(4) Height above the lowest river bed at dam	46·45 feet
(5) Height of the top of the dam above the crest of the spillway or weir	Top of the dam acts as spillway
(6) Maximum width at level of foundations	41 feet at R.L. 843·55 and 50 feet at R. L. 840·00
(7) Width at top	18·5 feet
(8) Batter of face-slopes	
(*a*) Upstream	Vertical and 1 in 12
(*b*) Downstream	Vertical and 2 in 3
(9) Length at top of the dam	3,345·75 feet
(*b*) Spillway	Top of the dam acts as spillway
(10) Cubic volume of the body of the dam	

B. OTHERS

(11) Material of which the dam is constructed	Plum concrete in *kankar* lime for hearting and rubble stone masonry used for facing
(12) Specific gravity	
(*a*) Masonry	2·24
(*b*) Concrete	
(13) Nature of protection and waterproofing of the upstream and downstream faces	Cement pointing
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundations of the dam	Cement pointing
(16) Contraction joints	
(17) Principal stresses in the masonry with a note of methods of calculations employed	
(18) Maximum pressure of foundations	
(19) Uplift pressure, calculated or measured	
(20) Measures adopted for preventing or counteracting uplift pressures	Concrete spur provided upstream and downstream

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory
(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads
    (*i*) Highways
    (*ii*) District Roads
    (*iii*) Village Roads
  (*e*) Railway Lines
  (*f*) Temples, mosques, *etc.*
  (*g*) Graves, *etc.*
  (*h*) Trees, gardens, pastures, houses, wells, *etc.*
  (*i*) Bridges
(3) Compensation paid under each category of item (2)
(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	The total length of the Dam, 3846 feet, acts as a spillway. Its maximum discharge capacity is 652,000 cusecs. In addition there are three river sluices, which can discharge 10,000 cusecs.
(2) Outlet works	There are 99 semi-automatic and 284 drop gates. Each gate measures 8 feet in height 10 feet in length.
(3) Scouring works	One sluice — 8 feet × 7½ feet Two sluices 8 feet × 10 feet
(4) Inspection facilities	No provision
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	It was designed by Sir Nethersole and was constructed by Mr. S. Athim, Executive Engineer
(2) Personnel	Sir M. Nethersole Mr. S. Athim, Executive Engineer
(3) Bibliography	

X-3. Lachura Dam

(Masonry)

I. GENERAL

(1) Height above the lowest river bed	45·39 feet
(2) Location	Uttar Pradesh (Dhasan river)
(3) Authority or owner	Uttar Pradesh Government
(4) Purpose-Main and subsidiary	Irrigation
(5) Year of commencement	1906
(6) Year of completion	1910
(7) Capital cost	
(a) Estimated	
(b) Actual	Rs. 7,02,288
(8) Culturable area commanded by the project	
(9) Area irrigated	
(11) Means of access	

II. GEOPHYSICAL

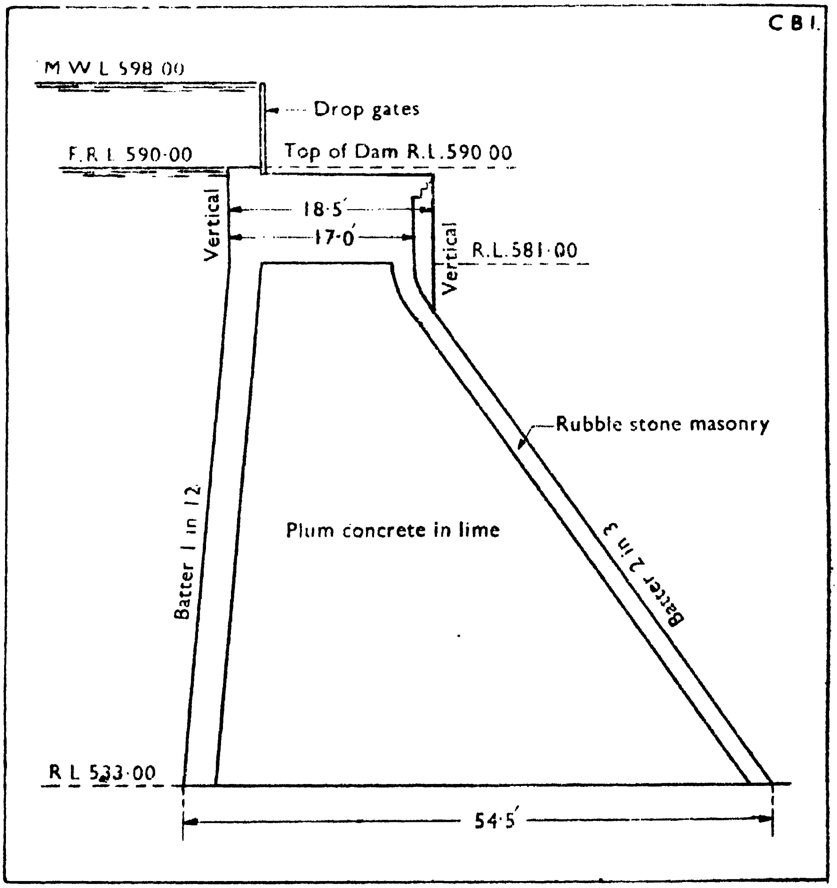
(1) Area of catchment	3,420 square miles
(2) Nature of catchment	Partly flat and partly hilly
(3) Mean annual precipitation	
(a) Rainfall	40 inches
(4) Total average annual yield of the catchment	1,608,654·54 acre feet
(5) Climate	Sub-tropical
(6) Temperature conditions and variations	Maximum temperature 115°F Minimum temperature 40°F
(7) Rate of Flow	
(a) Maximum	581,057 cusecs
(b) Minimum	No flow

(8) Detritus charge of the stream	It is generally silt laden and muddy in flood season
(9) Character (chemical) of the water stored in the reservoir	
(10) Geological features	
(*a*) of foundations	Hard rock and *moorum*
(*b*) of catchment area	It is mixed Bundelkhand soils
(11) Earthquake (Zone and intensities)	

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M. W. L.	R. L. 598·00
(*b*) F. R. L.	R. L. 590·00
(*c*) Area at M. W. L.	3·46 square miles
(*d*) Area at F. R. L.	
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	
(*b*) Live	29,155 acre feet
(*c*) Flood storage	
(*d*) Carry-over	
(3) Maximum height above the lowest point of foundations	57 feet
(4) Height above the lowest river bed at dam	45·39 feet
(5) Height of the top of the dam above the crest of the spillway or weir	Top of the dam acts as spillway
(6) Maximum width at level of foundation	54·5 feet
(7) Width at top	18·5 feet
(8) Batter of face slopes	
(*a*) Upstream	1 in 12 and vertical
(*b*) Downstream	1 in 1¼ and vertical
(9) Length at top of the dam	1,778·5 feet
(*a*) Non-overflow (*i*) Main	The whole top length of the dam acts as a spillway
(*b*) Spillway or weir	1,778·5 feet



Cross Section of Lachura Dam

(10) Cubic volume of the body of the dam	

B. OTHERS

(11) Material of which the dam is constructed	Plum concrete in *Kankar* lime for hearting with rubble stone facing
(12) Specific gravity	
(*a*) Masonry	2·24
(*b*) Concrete	2·24
(13) Nature of protection and waterproofing of the upstream and downstream faces	Cement pointing

(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundations of the dam	Cement pointing
(16) Contraction joints	
(17) Principal stresses in the masonry with a note of methods of calculations employed	
(18) Maximum pressure on foundations	
(19) Uplift pressure, calculated or measured	
(20) Measures adopted for preventing or counteracting uplift pressures	

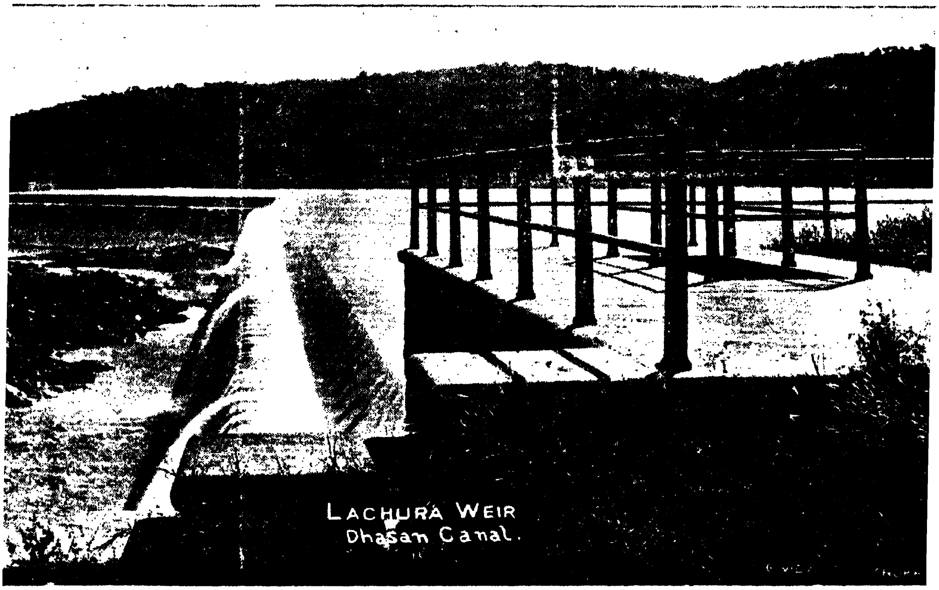
IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory

(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads
    (*i*) Highways
    (*ii*) District Roads
    (*iii*) Village Roads
  (*e*) Railway Lines
  (*f*) Temples, mosques, *etc.*
  (*g*) Graves, *etc.*
  (*h*) Trees, gardens, pastures, houses, wells, etc.
  (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders



Lachura Weir and Dhasan Canal

VI. AUXILIARY WORKS

(1) Surplussing works	The total length of the dam, 1,778·5 feet provided with drop gates each 10 feet by 8 feet, acts as a spillway, when gates are dropped. Maximum discharging capacity is 40,000 cusecs. In addition to this three river sluices are also provided to discharge 10,000 cusecs.
(2) Outlet works	Three canal sluices each 10 feet by 8 feet
(3) Scouring works	The river sluices, 10 feet by 8 feet also serve as scouring works
(4) Inspection facilities	
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the dam
  (*a*) Regulation
  (*b*) Silting of the reservoir
    (*i*) Total silt deposited
    (*ii*) Rate of silting
    (*iii*) Density of the silt deposited
    (*iv*) Rate of advancement of delta
  (*c*) Actual yield as against estimated
  (*d*) Various measurements and observations
    (*i*) Evaporation losses
    (*ii*) Sweating below the dam
    (*iii*) Temperature measurements
    (*iv*) Seepage and regeneration
  (*e*) Fish culture
  (*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel **Mr. H. Riggs, Executive Engineer**

(3) Bibliography

X. 4. Nagda Gojra Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	51 feet
(2) Location	Gwalior State, Narwar District Madhya Bharat Union, (Nagda *Nala* and adjoining streams)
(3) Authority or owner	Madhya Bharat Union
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1908
(6) Year of completion	1911
(7) Capital cost	
(*a*) Estimated	Rs. 87,636
(*b*) Actual	Rs. 82,869
(8) Culturable area commanded by the project	
(9) Area irrigated	
(11) Means of access	

II. GEOPHYSICAL

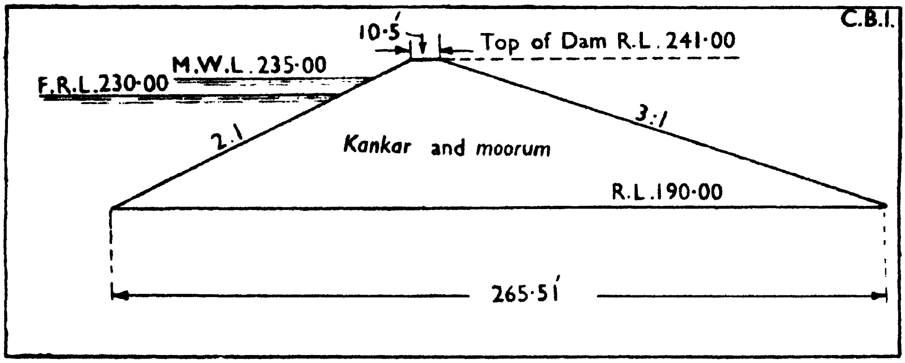
(1) Area of catchment	18 square miles
(2) Nature of catchment	Partly cultivated land and partly waste land
(3) Mean annual precipitation	
(*a*) Rainfall	31·7 inches
(4) Total average annual yield of the catchment	9585·32 acre feet
(5) Climate	Tropical
(6) Temperature conditions and variations	Intense heat in summer and nearly freezing in winter

(7) Rate of Flow	
(a) Maximum	
(b) Minimum	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	
(10) Geological features	
(a) of foundations	*Moorumy* soil partly cultivated and partly ravines
(b) of catchment	

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(a) M. W. L.	R. L. 235·00
(b) F. R. L.	R. L. 230·50
(c) Area at M. W. .L	1·34 square miles
(d) Area at F. R. L.	
(e) Maximum length	
(f) Maximum width	
(g) Length of periphery	
(2 Capacity of the reservoir	
(a) Gross	
(b) Live	9607·0 acre feet
(c) Flood storage	
(d) Carry-over	



Cross Section of Nagda Gojra Dam

(3) Maximum height above the lowest point of foundations	51 feet
(4) Height above the lowest river bed at dam	51 feet
(5) Height of the top of the dam above the crest of the spillway or weir	11·0 feet
(6) Maximum width at level of foundations	265·51 feet
(7) Width at top	10·5 feet
(8) Slopes	
(a) Upstream	As per cross section
(b) Downstream	
(9) Length at top of the dam	900 feet
(a) Non-overflow	
(i) Main	520 feet
(b) Spillway	380 feet { 100 feet *Pacca Weir* 280 feet Byewash
(10) Cubic volume of the body of the dam	950,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	*Kankar* and *moorum*
(12) Specific gravity	
(d) Earthfill	
(13) Nature of protection and waterproofing of the up-stream and downstream faces	
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundation of the dam	
(21) Hydraulic gradient for which the embankment is designed	
(22) Particular of the berm (if any) width and position	
(23) Position and form of the core wall (or other means of securing water tightness)	No core-wall

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*

(a) Crown waste

(b) Proprietory

2) *Dislocation*
- (*a*) Villages
- (*b*) Families
- (*c*) Population
- (*d*) Roads
  - (*i*) Highways
  - (*ii*) District Roads
  - (*iii*) Village Roads
- (*e*) Railway Lines
- (*f*) Temples, Mosques, *etc.*
- (*g*) Graves, etc.
- (*h*) Trees, gardens, pastures, houses, wells, *etc.*
- (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	*Pacca* waste weir = 100 feet long Bye wash = 280 feet long. Total waste weir length = 380 feet and discharging capacity 14,000 cusecs.
(2) Outlet works	One gate 2 feet by 2 feet
(3) Scouring works	
(4) Inspection facilities	Tunnel accessible from outside
(5) Fish-pass	
(6) Means for dissipating energy below the spillway.	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the dam
- (*a*) Regulation

- (*b*) Silting of the reservoir
  - (*i*) Total silt deposited
  - (*ii*) Rate of silting
  - (*iii*) Density of the silt deposited
  - (*iv*) Rate of advancement of delta
- (*c*) Actual yield as against estimated
- (*d*) Various measurements and observations
  - (*i*) Evaporation losses
  - (*ii*) Sweating below the dam
  - (*iii*) Temperature measurements
  - (*iv*) Seepage and regeneration
- (*e*) Fish culture
- (*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

IX—BIBLIOGRAPHY AND HISTORICAL

(1) Historical	The project was first proposed by Mr. Sydney Preston C.I.E. in his "Irrigation possibilities in the State", and was subsequently developed and construction carried out successfully under his guidance.
(2) Personnel	Mr. Sydney Preston.
(3) Bibliography	Preston Sydney "Irrigation possibilities in the State".

X. 5. Dhobni Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	53 feet
(2) Location	Gwalior State, Sheopur District Madhya Bharat Union (No particular stream)
(3) Authority or owner	Madhya Bharat Union
(4) Purpose—Main and Subsidiary	Irrigation
(5) Year of commencement	1907
(6) Year of completion	1911
(7) Capital cost	
(*a*) Estimated	Rs. 12,18,68
(*b*) Actual	Rs. 1,13,843
(8) Culturable area commanded by the project	
(9) Area irrigated	
(11) Means of access	

II. GEOPHYSICAL

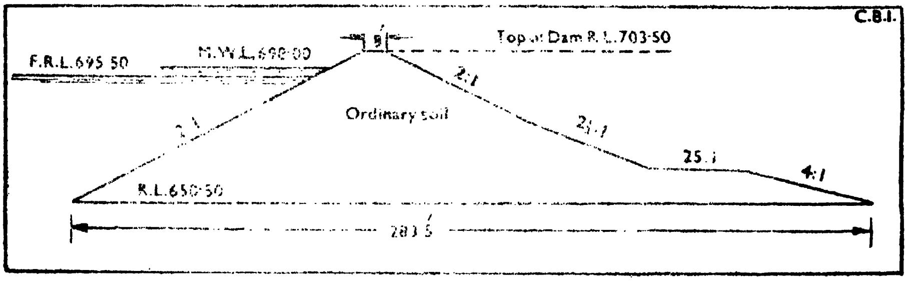
(1) Area of catchment	5 square miles
(2) Nature of catchment	
(3) Mean annual precipitation	
(*a*) Rainfall	28 inches
(4) Total average annual yield of the catchment	1433·0 acre feet
(5) Climate	Tropical
(6) Temperature conditions and variations	Intense heat in summer and nearly freezing in winter
(7) Rate of Flow	
(*a*) Maximum	
(*b*) Minimum	
(8) Detritus charge of the stream	

(9) Character (chemical) of the water stored in the reservoir	Turbid with finely divided suspended matter
(10) Geological features	
(*a*) of foundations	
(*b*) of catchment area	

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M.W.L.	R.L. 698·00
(*b*) F.R.L.	R.L. 695·50
(*c*) Area at M.W.L.	0·38 square mile
(*d*) Area at F.R.L.	
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	
(*b*) Live	2,752 acre feet
(*c*) Flood storage	
(*d*) Carry-over	



Cross Section of Dhobni Dam

(3) Maximum height above the lowest point of foundations	53 feet
(4) Height above the lowest river bed at dam	53 feet
(5) Height of the top of the dam above the crest of the spillway or weir	8 feet
(6) Maximum width at level of foundation	283·5 feet
(7) Width at top	8 feet
(8) Slopes	
(*a*) Upstream	2 : 1
(*b*) Downstream	2 :1 , 2½ : 1, 25 :1 and 4 : 1

(9) Length at top of the dam	3,000 feet
(a) Non overflow	
(i) Main	2,800 feet
(b) Spillway	200 feet
(10) Cubic volume of the body of the dam	7,000,000 feet

B. OTHERS

(11) Material of which the dam is constructed	Ordinary soil
(12) Specific gravity	
(d) Earthfill	
(13) Nature of protection and water proofing of the upstream and downstream faces	Upstream face protected with stone pitching
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundations of the dam	
(21) Hydraulic gradient for which the embankment is designed	
(22) Particular of the berm (if any), width and position	
(23) Position and form of the core wall (or other means of securing water tightness)	
(24) Batter (if any) of the core wall	
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	
(26) Method of keying core-wall or other wall in the underlying ground	
(27) Nature of material forming the core or other wall	

V. AUXILIARY WORKS

(1) Surplussing works	*Pacca* waste weir, 200 feet long, has a discharging capacity of 3,350 cusecs
(2) Outlet works	One gate 2 feet × 2 feet
(3) Scouring works	
(4) Inspection facilities	Tunnel accessible for inspection
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the dam
  - (*a*) Regulation
  - (*b*) Silting of the reservoir
    - (*i*) Total silt deposited
    - (*ii*) Rate of silting
    - (*iii*) Density of the silt deposited
    - (*iv*) Rate of advancement of delta
  - (*c*) Actual yield as against estimated
  - (*d*) Various measurements and observations
    - (*i*) Evaporation losses
    - (*ii*) Sweating below the dam
    - (*iii*) Temperature measurements
    - (*iv*) Seepage and regeneration
  - (*e*) Fish culture
  - (*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

VII. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	This is a very old tank. Col. Pitcher the then Chief Engineer Irrigation Works inaugurated the system of irrigation works and remodelled this tank, which was completed in 1911.
(2) Personnel	Col. Pitcher, Chief Engineer
(3) Bibliography	

X. 6. Pahari Dam

(Masonry)

I. GENERAL

(1) Height above the lowest river bed	45·71 feet
(2) Location	The dam lies partly in United Provinces and partly in Central Provinces (Dhasan river)
(3) Authority or owner	Uttar Pradesh Govt.
(4) Purpose Main and subsidiary	Irrigation
(5) Year of commencement	1907
(6) Year of completion	1913
(7) Capital cost	
(*a*) Estimated	
(*b*) Actual	Rs. 8,64, 578
(8) Culturable area commanded by the project	
(9) Area irrigated	
(11) Means of access	

II. GEOPHYSICAL

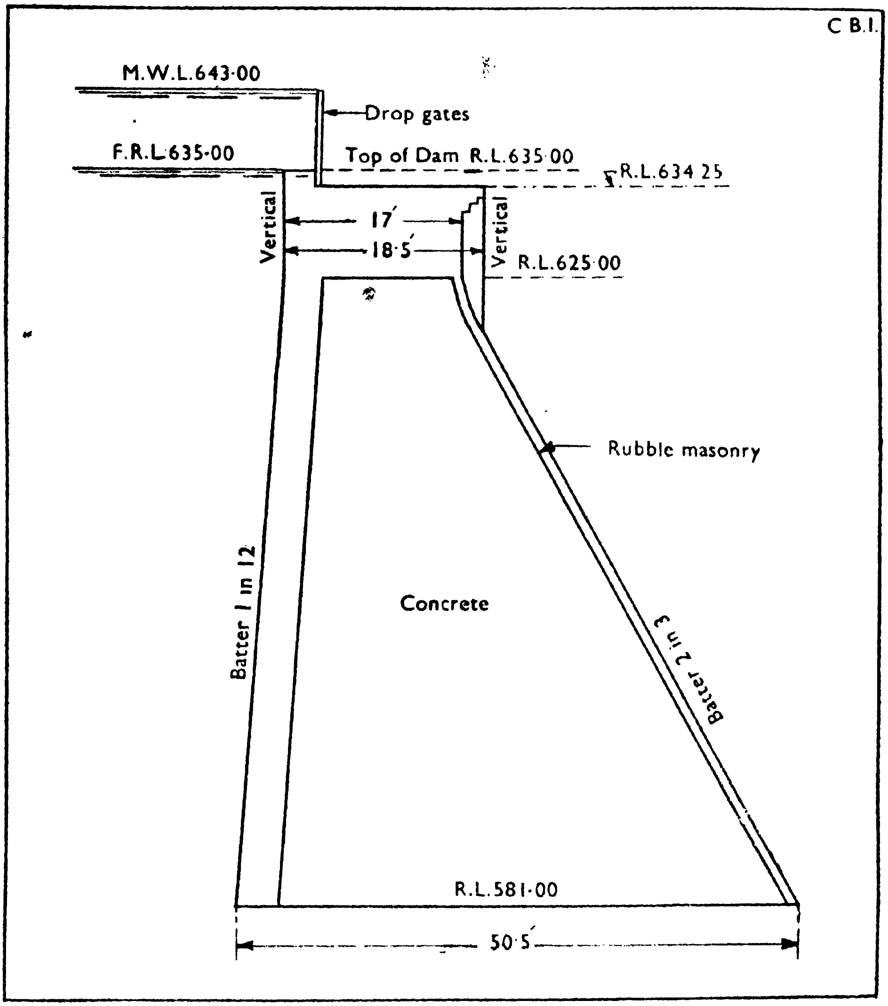
(1) Area of catchment	3,026 square miles
(2) Nature of catchment	Partly hilly and partly plains
(3) Mean annual precipitation	
(*a*) Rainfall	40 inches
(4) Total average annual yield of the catchment	1,377,410 acre feet
(5) Climate	Sub-tropical
(6) Temperature conditions and variations	Maximum temperature 115° F Minimum temperature 40° F
(7) Rate of Flow	
(*a*) Maximum	465,100 cusecs
(*b*) Minimum	No flow
(8) Detritus charge of the stream	Generally silt laden and mudddy during the flood season
(9) Character (chemical) of the water stored in the reservoir	Soft and portable water

(10) Geological features	
(a) of foundations	Rocky
(b) of catchment area	

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(a) M.W.L.	R.L. 643·00
(b) F.R.L.	R.L. 635·00
(c) Area at M.W.L.	8·43 square miles
(d) Area at F.R.L.	
(e) Maximum length	
(f) Maximum width	
(g) Length of periphery	
(2) Capacity of the reservoir	
(a) Gross	
(b) Live	64,325 acre feet
(c) Flood storage	
(d) Carry-over	
(3) Maximum height above the lowest point of foundations	54 feet upto top of dam R. L. 635·00+ 8 feet height upto top of gates R.L. 643·00
(4) Height above the lowest river bed at dam	45·71 feet upto top of dam R.L. 635·0
(5) Height of the top of the dam above the crest of the spillway or weir	Top of the dam acts as a spillway
(6) Maximum width at level of foundation	50·5 feet
(7) Width at top	18·5 feet overall width
(8) Batter of face slopes	
(a) Upstream	1 in 12 and vertical
(b) Downstream	1 in 1½ and vertical
(9) Length at top of the dam	1,903·7 feet
(a) Non-overflow	Provided with falling gates, which can be raised, if required
(i) Main	
(b) Spillway or Weir	1,903·7 feet
(10) Cubic volume of the body of the dam	



Cross Section of Pahari Dam

B. OTHERS

(11) Material of which the dam is constructed	Cement plum concrete 1 : 5 for hearting and rubble stone masonry for casing
(12) Specific gravity (*b*) Concrete	 2·24
(13) Nature of protection and waterproofing of the upstream and downstream faces	Cement pointing

(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundation of the dam	Cement pointing.
(16) Contraction joints	
(17) Principal stresses in the masonry with a note of methods of calculations employed	
(18) Maximum pressure on foundations	
(19) Uplift pressure, calculated or measured	
(20) Measures adopted for preventing or counteracting uplift pressures	
(21) Hydraulic gradient for which the embankment is designed	

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory
(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads
    (*i*) Highways
    (*ii*) District Roads
    (*iii*) Village Roads
  (*e*) Railway Lines
  (*f*) Temples, mosques, *etc.*
  (*g*) Graves, *etc.*
  (*h*) Trees, gardens, pastures, houses, wells, *etc.*
  (*i*) Bridges
(3) Compensation paid under each category of item (2)
(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Total length of the dam, 1903·7 feet, is provided with drop gates each 10 feet by 8 feet in height. The whole length of the dam acts as a spillway when the gates are dropped, with maximum discharging capacity of 465,100 cusecs. In addition to this six river sluices are also provided which can discharge 26,000 cusecs.
(2) Outlet works	The six river sluices of which 3 are 20 feet by 9 feet, two 10·25 feet by 8 feet and one 7·5 feet by 8·25 feet
(3) Scouring works	They discharge flood-water, are used as scouring sluices and also serve drawing off water for canal purpose.
(4) Inspection facilities	
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the dam

- (*a*) Regulation
- (*b*) Silting of the reservoir
  - (*i*) Total silt deposited
  - (*ii*) Rate of silting
  - (*iii*) Density of the silt deposited
  - (*iv*) Rate of advancement of delta
- (*c*) Actual yield as against estimated
- (*d*) Various measurements and observations

        - (*i*) Evaporation losses
        - (*ii*) Sweating below the dam
        - (*iii*) Temperature measurements
        - (*iv*) Seepage and regeneration
    - (*e*) Fish culture
    - (*f*) Anti-malaria measures
- (5) Recreation facilities
- (6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

(3) Bibliography

X. 7. Antal Wasa Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	52·6 feet
(2) Location	Gwalior State Malwa Prant District. Madhya Bharat Union
(3) Authority or owner	Madhya Bharat Union
(4) Purpose—Main and Subsidiary	Irrigation
(5) Year of commencement	1908
(6) Year of completion	1913
(7) Capital cost	
(a) Estimated	Rs. 1,42,139
(b) Actual	Rs. 1,18,710
(8) Culturable area commanded by the project	
(9) Area irrigated	
(11) Means of access	

II. GEOPHYSICAL

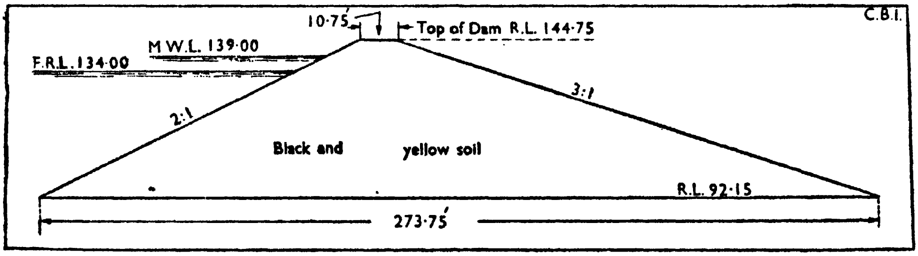
(1) Area of catchment	12 square miles
(2) Nature of catchment	
(3) Mean annual precipitation	
(a) Rainfall	25·1 inches.
(4) Total average annual yield of the catchment	3,710·0 acre feet
(5) Climate	Tropical
(6) Temperature conditions and variations	Intense heat in summer and near freezing in winter
(7) Rate of Flow	
(a) Maximum	
(b) Minimum	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	Turbid with finely divided suspended matter

(10) Geological features	
(*a*) of foundations (*b*) of catchment area	Black cotton waste and cultivated soil land.

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M.W.L.	R.L. 139·00
(*b*) F.R.L.	R.L. 134·00
(*c*) Area at M.W.L.	0·85 square mile
(*d*) Area at F.R.L.	
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	
(*b*) Live	4,759·4 acre feet
(*c*) Flood storage	
(*d*) Carry-over	



Cross section of Antal Wasa Dam

(3) Maximum height above the lowest point of foundations	52·6 feet
(4) Height above the lowest river bed at dam	52·6 feet
(5) Height of the top of the dam above the crest of the spillway or weir.	10·75 feet
(6) Maximum width at level of foundation	273·75 feet
(7) Width at top	10·75 feet
(8) Slopes	
(*a*) Upstream	2 : 1
(*b*) Downstream	3 : 1.

(9) Length at top of the dam	5,000 feet
(*a*) Non-overflow	
(*i*) Main	
(*b*) Spillway	55 feet *pacca* and bye wash
(10) Cubic volume of the body of the dam	7,420,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Black and yellow soil
(12) Specific gravity	
(*d*) Earthfill	
(13) Nature of protection and waterproofing of the upstream and downstream faces	Upstream side protected by stone pitching
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundation of the dam	
(21) Hydraulic gradient for which the embankment is designed	
(22) Particulars of the berm (if any) width and position	
(23) Position and form of the core-wall (or other means of securing water tightness)	
(24) Batter (if any) of the core wall	
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	
(26) Method of keying core-wall or other wall in the underlying ground	
(27) Nature of material forming the core or other wall	

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory
(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads :
    (*i*) Highways
    (*ii*) District Roads
    (*iii*) Village Roads

(*e*) Railway Lines
(*f*) Temples, mosques, etc.
(*g*) Graves, etc.
(*h*) Trees, gardens, pastures, houses, wells, etc.
(*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	*Pacca* waste weir 55 feet in length and bye-wash , total discharging capacity 10,000 cusecs
(2) Outlet works (3) Scouring works	Sluice gate 2 feet × 2 feet
(4) Inspection facilities	Tunnel is accessible for inspection
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the dam
(*a*) Regulation
(*b*) Silting of the reservoir
(*i*) Total silt deposited
(*ii*) Rate of silting
(*iii*) Density of the silt deposited
(*iv*) Rate of advancement of delta
(*c*) Actual yield as against estimated

- (*d*) Various measurements and observations
  - (*i*) Evaporation losses
  - (*ii*) Sweating below the dam
  - (*iii*) Temperature measurements
  - (*iv*) Seepage and regeneration
- (*e*) Fish culture
- (*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	Survey of the tank was taken up in 1908 and construction completed in 1913 during the tenure of office of Mr. Sidney Preston, C.I.E., Member Board of Irrigation.
(2) Personnel	
(3) Bibliography	

X. 8. Ghori Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed.	41·16 feet.
(2) Location	Mirzapur District, Uttar Pradesh (Ghori *Nadi*).
(3) Authority or owner	Uttar Pradesh Government.
(4) Purpose-Main and subsidiary	Irrigation
(5) Year of commencement	1910
(6) Year of completion	1914
(7) Capital cost	
(*a*) Estimated	2,64,527
(*b*) Actual	2,53,256
(8) Culturable area commanded by the project.	4600 acres
(9) Area irrigated	1450 acres
(11) Means of access	Nearest Railway Station Mirzapur. From Mirzapur to Marhian 20 miles by Provincial road and from Marhian fair weather road.

II. GEOPHYSICAL

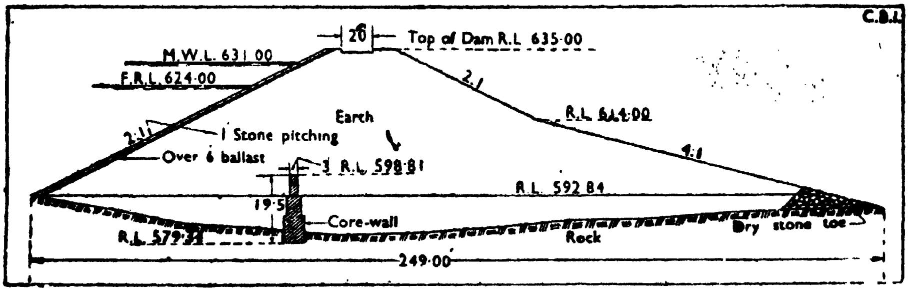
(1) Area of catchment	14 square miles
(2) Nature of catchment	Hilly with steep slopes and covered with thick jungle
(3) Mean annual precipitation	
(*a*) Rainfall	47 inches
(4) Total average annual yield of the catchment	10,606 acre feet
(5) Climate	Hot
(6) Temperature conditions and variations	Maximum temperature — 115°F Minimum temperature — 40°F

(7) Rate of Flow	
(*a*) Maximum	2,430 cusecs
(*b*) Minimum	No flow
(8) Detritus charge of the stream	Generally silt laden and muddy in flood season
(9) Character (chemical) of the water stored in the reservoir.	Hard
(10) Geological features	
(*a*) of foundations	Rocky.
(*b*) of catchment area	

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M. W. L.	R. L. 631·00
(*b*) F. R. L.	R. L. 624·00
(*c*) Area at M. W. L.	
(*d*) Area at R. F. L.	1·16 square miles
(*e*) Maximum length	1·5 miles
(*f*) Maximum width	1·25 miles
(*g*) Length of periphery	5·5 miles
(2) Capacity of the reservoir	
(*a*) Gross	7,436 acre feet
(*b*) Live	7,436 acre feet
(*c*) Flood storage	4,590 acre feet
(*d*) Carry over	



Cross Section of Ghori Dam.

(3) Maximum height above the lowest point of foundations	54·66 feet
(4) Height above the lowest river bed at dam	41·16 feet

(5) Height of the top of the dam above the crest of the spillway or weir	10 feet
(6) Maximum width at level of foundation	249·00 feet
(7) Width at top	20 feet overall
(8) Slopes	
(a) Upstream	2 : 1
(b) Downstream	2 : 1 and 4 : 1
(9) Length at top of the dam	3,950 feet
(a) Non-over flow	
(i) Main	3,510 feet
(ii) Subsidiary	
(b) Spillway or weir	440 feet
(10) Cubic volume of the body of the dam.	13,302,528 cubic feet

B. OTHERS

(11) Material of which the dam is constructed.	Red clay and black soil
(12) Specific gravity	
(a) Masonry	150 lbs
(d) Earthfill	110 lbs
(13) Nature of protection and waterproofing of the upstream and downstream faces.	Stone pitching upstream
(14) Provision for dealing with seepage and drainage water.	Dry stone toe
(15) Means of securing water tightness of the foundation of the dam.	By means of masonry core-wall
(22) Particulars of the berm (if any) width and position	Berm 10 feet wide downstream at R.L. 600·00
(23) Position and form of the core-wall (or other means of securing water tightness)	As per cross section
24) Batter (if any) of the core-wall	As per cross section
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness.	13·5 feet
(26) Method of keying core-wall or other wall in the underlying ground.	By means of trenching
(27) Nature of material forming the core or other wall.	Rubble stone masonry and concrete in lime

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged* :	
(*a*) Crown waste	90 % of the area submerged in reservoir.
(*b*) Proprietory	10% of the area submerged in the reservoir.
(2) *Dislocation* :	
(*a*) Villages	
(*b*) Families	
(*c*) Population	
(*d*) Roads :	
(*i*) Highways	
(*ii*) District roads	
(*iii*) Village roads	
(*e*) Railway lines	
(*f*) Temples, mosques, etc.	
(*g*) Graves, etc.	
(*h*) Trees, gardens, pastures, houses, wells, *etc.*	Only a few trees and jungle were submerged.
(*i*) Bridges	
(3) Compensation paid under each category of item (2).	
(4) Method of compensating for land of dispossessed landholders.	By cash as cost of land submerged.

V. AUXILIARY WORKS

(1) Surplussing works	There are two escapes, one on flank and the other on saddle, 140 feet and 300 feet in length respectively, and can discharge 11,848 cusecs.
(2) Outlet works	One canal head sluice gate 2·5 feet by 2 feet
(3) Scouring works	
(4) Inspection facilities	Fair weather road upto the site.
(5) Fish-pass	
(6) Means for dissipating energy below the spillway.	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	All earth work done by manual labour
(2) Changes introduced in the plans of the dam and in the method of carrying out the work.	
(3) Noteworthy occurrences and accidents	In August 1914 just after the completion the bund breached due to sudden and heavy downpour.
(4) Operation of the dam	
(*a*) Regulation	Excess water is escaped over the flank escape.
(*b*) Silting of the reservoir	
(*i*) Total silt desposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited.	100 lbs.
(*iv*) Rate of advancement of delta.	
(*c*) Actual yield as against estimated.	
(*d*) Various measurements and observations.	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	Pits have been drained.
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam.	Earthen bunds of great height should be built carefully on sand stone rock, cavities below the rock, sometime cause breaches.

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	The work was started in 1912 and was completed without any major difficulty in 1914.

(2) Personnel	1. Mr. B. D'O Dasley, Executive Engineer. 2. Mr. A. Woodhead, Assistant Engineer. 3. Mr. A. V. Morphy, Assistant Engineer. 4. Mr. H. F. Hutchinson, Assistant Engineer.
(3) Bibliography	

X. 9. Gangao Weir Dam

(Masonry)

I. GENERAL

(1) Height above the lowest river bed	43 feet
(2) Location	Uttar Pradesh (Ken river)
(3) Authority or owner	Uttar Pradesh Government
(4) Purpose-Main and subsidiary	Irrigation
(5) Year of commencement	1909
(6) Year of completion	1915
(7) Capital cost	
(a) Estimated	Rs. 19,74,148
(b) Actual	Rs. 17,95,536
(8) Culturable area commanded by the project	7,81,000 acres
(9) Area irrigated	1,42,561 acres
(11) Means of access	Satna Railway Station on Itarsi Allahabad Line 75 miles from Gangao Dam Harpalpur Railway Station on Manikpur Jhansi Line is 67 miles from Gangao Dam and a regular bus service exists from Harpalpur and Satna Railway station up to Bamari Inspection House from Bamari Inspection House Pucca Road to Gangao. Distance 12 miles.

II. GEOPHYSICAL

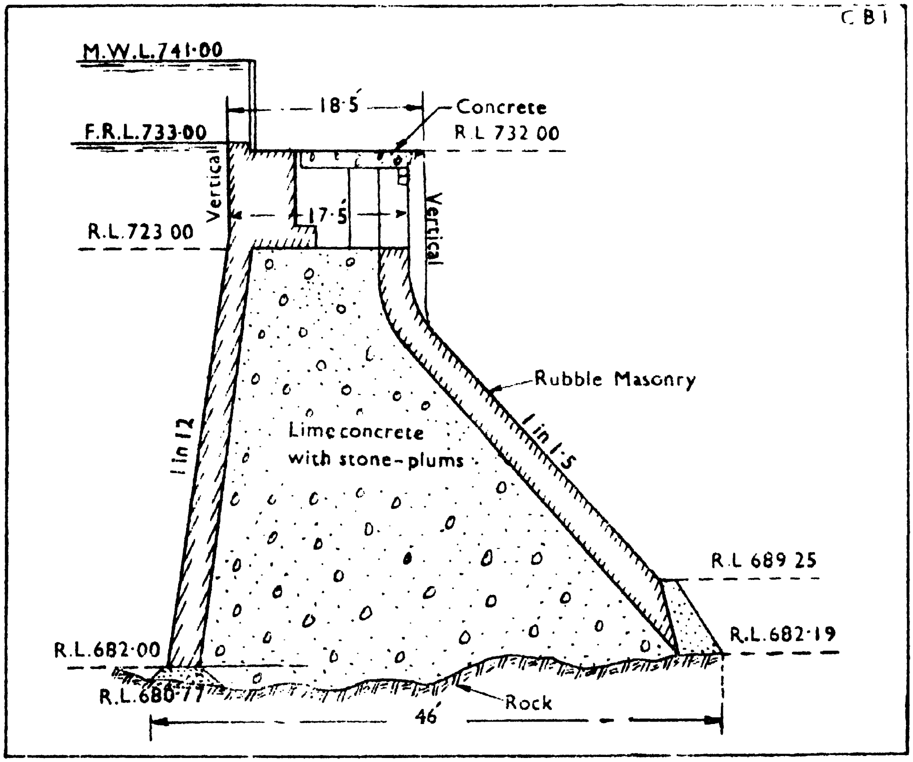
(1) Area of catchment	7,199 square miles
(2) Nature of catchment	Hilly
(3) Mean annual precipitation	
(*a*) Rainfall	27·6 inches
(4) Total average annual yield of the catchment	5,899,908 acre feet
(5) Climate	Dry
(6) Temperature conditions and variations	
(7) Rate of Flow	
(*a*) Maximum	624, 000 cusecs
(*b*) Minimum	50 cusecs
(8) Detritus charge of the stream	Almost silt laden and suddy during the flood season
(9) Character (chemical) of the water stored in the reservoir	
(10) Geological features	
(*a*) of foundations	Rocky
(*b*) of catchment area	Hard soil
(11) Earthquake (Zone and intensities)	

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M.W.L.	R.L.741·00
(*b*) F.R.L.	R.L.733·00
(*c*) Area at M.W.L.	8·12 square miles
(*d*) Area at F.R.L.	
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	

(2) Capacity of the reservoir	
(*a*) Gross	80,900 acre feet upto the top of gates
(*b*) Live	48,324 acre feet upto the crest level
(*c*) Flood storage	
(*d*) Carry-over	



Cross Section of Gangao Dam.

(3) Maximum height above the lowest point of foundations	53 feet
(4) Height above the lowest river bed at dam	43 feet
(5) Height of the top of the dam above the crest of the spillway or weir	Top of the gate above crest level of weir is 8 feet and top of earth in afflux levied above crest level of river is 19 feet

(6) Maximum width at level of foundation	46 feet
(7) Width at top	18·5 feet overall
(8) Batter of face slopes	
(a) Upstream	1 in 12 and vertical
(b) Downstream	1 in 1½ and vertical
(9) Length at top of the dam	2,629 feet
(a) Non-overflow (i) Main	When the gates are dropped the total length of the dam acts as a spill-way
(b) Spillway or weir	2,629 feet
(10) Cubic volume of the body of the dam	2,749,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Rubble stone masonry for casing with plum concrete in lime for hearting
(12) Specific gravity	
(b) Concrete	2·24
(13) Nature of protection and water-proofing of the upstream and downstream faces	Cement pointing
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundation of the dam	Cement pointing
(16) Contraction joints	
(17) Principal stresses in the masonry with a note of methods of calculations employed	
(18) Maximum pressure of foundations	
(19) Uplift pressure, calculated or measured	

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*

(a) Crown waste

(b) Proprietory

(2) *Dislocation*
  - (*a*) Villages
  - (*b*) Families
  - (*c*) Population
  - (*d*) Roads
    - (*i*) Highways
    - (*ii*) District roads
    - (*iii*) Village roads
  - (*e*) Railway lines
  - (*f*) Temples, mosques, etc.
  - (*g*) Graves, etc.
  - (*h*) Trees, gardens, pastures, Houses, wells, etc.
  - (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Floods pass over the weir crest which is provided with steel drop gates 8 feet high by 10 feet wide, which are lowered during the flood season.
(2) Outlet works	Two Stoney sluices each 9·5 feet by 7·5 feet and two Roorkee pattern sluices each 10 feet by 10 feet are provided. Maximum head over the former is 51 feet and on the latter 27 feet.
(3) Scouring works	
(4) Inspection facilities	
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	A sub-weir has been provided below the main weir; a water cushion is provided

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the dam	During floods (all the gates lowered) water passes over the weir at the close of the rainy season (say at the end of September) gates are raised and the reservior is filled upto R. L. 741·0.
(*a*) Regulation	Done by opening sluices provided in the dam
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	Actual yield is 50,972 acre feet against 80,876 acre feet orginally designed
(*d*) Various measurements and observations	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	
(2) Personnel	1. Mr. A. Singleton Hobbs, Executive Engineer (2) Messrs. Ford MacDonald, Contractors
(3) Bibliography	

X. 10. Kotra-Khamba Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	59·4 feet
(2) Location	Banda District, Uttar Pradesh (Hagni *Nadi*)
(3) Authority or owner	Uttar Pradesh Government.
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1912
(6) Year of completion	1915
(7) Capital cost	
(*a*) Estimated	
(*b*) Actual	Rs. 51,621/-
(8) Culturable area commanded by the project	1,900 acres
(9) Area irrigated	135 acres
(11) Means of access	It is accessible from Bargarh Railway Station (Great Indian Peninsular Railway) on Bargarhmau District *kacha* Road about four miles and then on foot about two miles to the right in hilly tract. No horse or any other conveyance can easily reach the Dam site.

II. GEOPHYSICAL

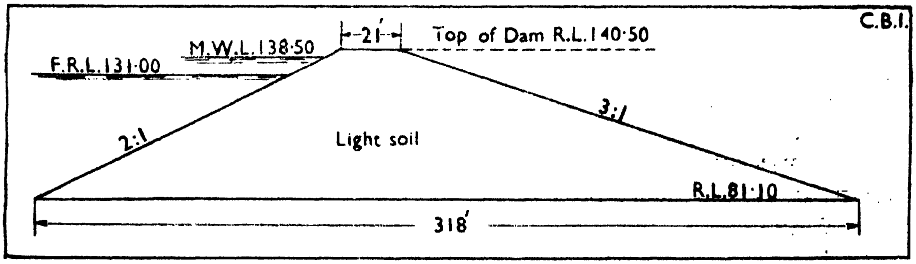
(1) Area of catchment	2·6 square miles
(2) Nature of catchment	Hilly
(3) Mean annual precipitation	
(a) Rainfall	36 inches
(4) Total average annual yield of the catchment	1,311 acre feet
(5) Climate	Dry
(6) Temperature conditions and variations	

(7) Rate of Flow		
(*a*) Maximum	30 cusecs	
(*b*) Minimum	No flow	
(8) Detritus charge of the stream	It is generally muddy during the flood season. Very little silt carried in the reservoir	
(9) Character (chemical) of the water stored in the reservoir	Clear except in the flood season	
(10) Geological features		
(*a*) of foundations	Kankar and Parwa soils	
(*b*) of catchment area	Hard soil	
(11) Earthquake (zone and intensities)	There have been light tremors, but causing no damage	

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data		
(*a*) M. W. L.	138·50	From arbitrary datum
(*b*) F. R. L.	131·00	
(*c*) Area at M. W. L.		
(*d*) Area at F. R. L.		
(*e*) Maximum length		
(*f*) Maximum width		
(*g*) Length of periphery		
(2) Capacity of the reservoir		
(*a*) Gross	3,099 acre feet	
(*b*) Live	2,480 acre feet	
(*c*) Flood storage		
(*d*) Carry-over		



Cross Section of Kotra Khamba Dam

(3) Maximum height above the lowest point of foundations	59·4 feet
(4) Height above the lowest river bed at dam	59·4 feet
(5) Height of the top of the dam above the crest of the spillway or weir	9·5 feet
(6) Maximum width at level of foundation	318 feet
(7) Width at top	21 feet
(8) Slopes	
(*a*) Upstream	2 : 1
(*b*) Downstream	3 : 1
(9) Length at top of the dam	2,650 feet (both the lengths)
(*a*) Non-overflow	
(*i*) Main	2,610 feet.
(*b*) Spillway or weir	40 feet.
(10) Cubic volume of the body of the dam	2,859,000 cubic feet (both the lengths)

B. OTHERS

(11) Material of which the dam is constructed	Light soil
(12) Specific gravity	
(13) Nature of protection and waterproofing of the upstream and downstream faces	Upstream face pitched with dry stones upto M. W. L.
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundation of the dam	
(22) Particulars of the berm (if any) width and position	No berm
(23) Position and form of the core wall (or other means of securing water tightness)	No core wall

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*

(*a*) Crown waste

(*b*) Proprietory

(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads
    (*i*) Highways
    (*ii*) District roads
    (*iii*) Village roads
  (*e*) Railway lines
  (*f*) Temples, mosques, etc.
  (*g*) Graves, etc.
  (*h*) Trees, gardens, pastures, houses, wells, etc.
  (*i*) Bridges
(3) Compensation paid under each category of item (2)
(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	A masonry escape 40 feet in length and designed to discharge 2,310 cusecs maximum up to the water depth of 4·5 feet above the crest
(2) Outlet works	Canal sluice size of aperture 2·5×2 feet
(3) Scouring works	
(4) Inspection facilities	
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	All work was done by manual labour
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurrences and accidents	

(4) Operation of the dam	
(*a*) Regulation	Through sluice openings
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	
(*d*) Various measurements and observations	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	Originally the Kotra Khamba tank was proposed and recommended by Mr. C. A. Silberrad, Collector of Banda. Later on it was taken up by Mr. F. F. Bios, Executive Engineer, who framed the scheme, and submitted to the Government with complete estimate, *etc.*, The estimate was sanctioned in 1912, and the work was started immediately. In 1915 the work was completed at the total cost of Rs. 51,621
(2) Personnel	Mr. F. F. Bios, Executive Engineer
	Mr. Mohsin Ali, Assistant Engineer
(3) Bibliography	

X. 11. Garai Canals Upper Storage

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	60·65 feet
(2) Location	Mirzapur district, Uttar Pradesh (Garai Nadi)
(3) Authority or owner	Uttar Pradesh Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1913
(6) Year of completion	1915
(7) Capital cost	
(*a*) Estimated	
(*b*) Actual	
(8) Culturable area commanded by the project	
(9) Area irrigated	
(11) Means of access	It is accessible from Ahraura road Railway Station (East Indian Railway) along the metalled road to Ahraura town. Thence along the district board unmetalled road leading to Robertsganj and then by an approach road to the dam. The total distance from Ahraura road station to the dam is 22 miles. The road is motorable in dry weather.

II. GEOPHYSICAL

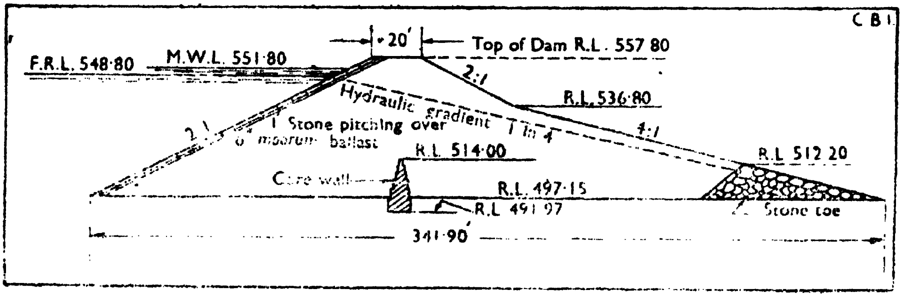
(1) Area of catchment	29 square miles
(2) Nature of catchment	Hilly steep slopes, marked with thick jungle
(3) Mean annual precipitation	
(*a*) Rainfall	47 inches
(4) Total average annual yield of the catchment	24,046 acre feet

(5) Climate	Hot.
(6) Temperature conditions and variations.	Maximum 115°F. Minimum 40°F.
(7) Rate of flow	
(a) Maximum	6·300 cusecs
(b) Minimum	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	Slightly hard with a small percentage of vegetable matter
(10) Geological features	
(a) of foundations	Rocky
(b) of catchment area	
(11) Earthquake (zone and intensities)	Not in the reach of earthquake zone.

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(a) M. W. L.	R. L. 551·80
(b) F. R. L.	R. L. 548·80
(c) Area at M. W. L.	
(d) Area at F. R. L.	
(e) Maximum length	
(f) Maximum width	
(e) Length of periphery	
(2) Capacity of the reservoir	
(a) Gross	(a) 21,924 acre feet
(b) Live	
(c) Flood storage	
(d) Carry over	



Cross Section of the Garai Canals (Upper Storage).

(3) Maximum height above the lowest point of foundations	60·65 feet
(4) Height above the lowest river bed at dam	60·65 feet
(5) Height of the top of the dam above the crest of the spillway or weir.	9 feet
(6) Maximum width at level of foundation.	341·90 feet
(7) Width at top	20 feet
(8) Slopes	
(*a*) Upstream	2 : 1
(*b*) Downstream	2 : 1 and 4 : 1
(9) Length at top of the dam	3,875 feet
(*a*) Non overflow	
(*i*) Main	(*i*) 2,895·5 feet
(*ii*) Subsidiary	
(*b*) Spillway or Weir	(*b*) 979·5 feet
(10) Cubic volume of the body of the dam	10,166,966 cubic feet

B. OTHERS

(11) Material of which the dam is constructed.	Red and black soil
(12) Specific gravity	
(*c*) Rockfill	
(*d*) Earth fill	
(13) Nature of protection and water proofing of the upstream and downstream faces	Stone pitching over 6" layer of *moorum* on upstream side and provided with a toe pitched with stones.
(14) Provision for dealing with seepage and drainage water	Downstream toe pitched with stones
(15) Means of securing water tightness of the foundation of the dam	By means of masonry core-wall
(21) Hydraulic gradient for which the embankment is designed	
(22) Particulars of the berm (if any) width and position	Berm 10 feet only where depth of Nala above 40 feet
(23) Position and form of the core-wall (or other means of securing water tightness)	As per sketch
(24) Batter (if any) of the core-wall	6 inches projections on each side (as per sketch).

(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	5·18 feet.
(26) Method of keying core-wall or other wall in the underlying ground	By means of masonry core wall.
(27) Nature of material forming the core or other wall	Rubble masonry and concrete in lime

V. AUXILIARY WORKS

(1) Surplussing works	The dam is provided with two weirs 583·5 feet and 396 feet on left and right flank respectively and can discharge 15,300 cusecs with a maximum water depth of 3 feet over crest.
(2) Outlet works	Nadi sluice and gate No. 3 feet × 4 feet
(3) Scouring works	
(4) Inspection facilities	
(5) Fish pass	
(6) Means for dissipating energy below the spillway.	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	The work has mostly been carried on by manual labour with the help of a light railway and tiptrucks.
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurrences and accidents	
(4) Operation of the dam.	
(*a*) Regulation	
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated.	
(*d*) Various measurements and observations.	
(*i*) Evaporation losses.	
(*ii*) Sweating below the dam	

(*iii*) Temperature measurements
(*iv*) Seepage and regeneration.
(*e*) Fish culture.
(*f*) Ant-malaria measures
(5) Recreation facilities
(6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

1. D. B'O Jouley, Executive Engineer.
2. W. E. B'uzzard, Assistant Engineer.

(3) Bibliography

X. 12 Tigra Dam

(Masonry)

I. GENERAL

(1) Height above the lowest river bed	79·1 feet	
(2) Location	Gird District, Madhya Bharat Union (Sank river)	
(3) Authority or owner	Madhya Bharat Union	
(4) Purpose—Main and subsidiary	Domestic Supply and irrigation	
(5) Year of commencement	1909	It breached in 1917 and completely restored in 1929
(6) Year of completion	1917	
(7) Capital cost		
(*a*) Estimated	Rs. 56,75,481/-	
(*b*) Actual	Rs. 53,05,978/-	
(8) Culturable area commanded by the project		
(9) Area irrigated		
(11) Means of access		

II. GEOPHYSICAL

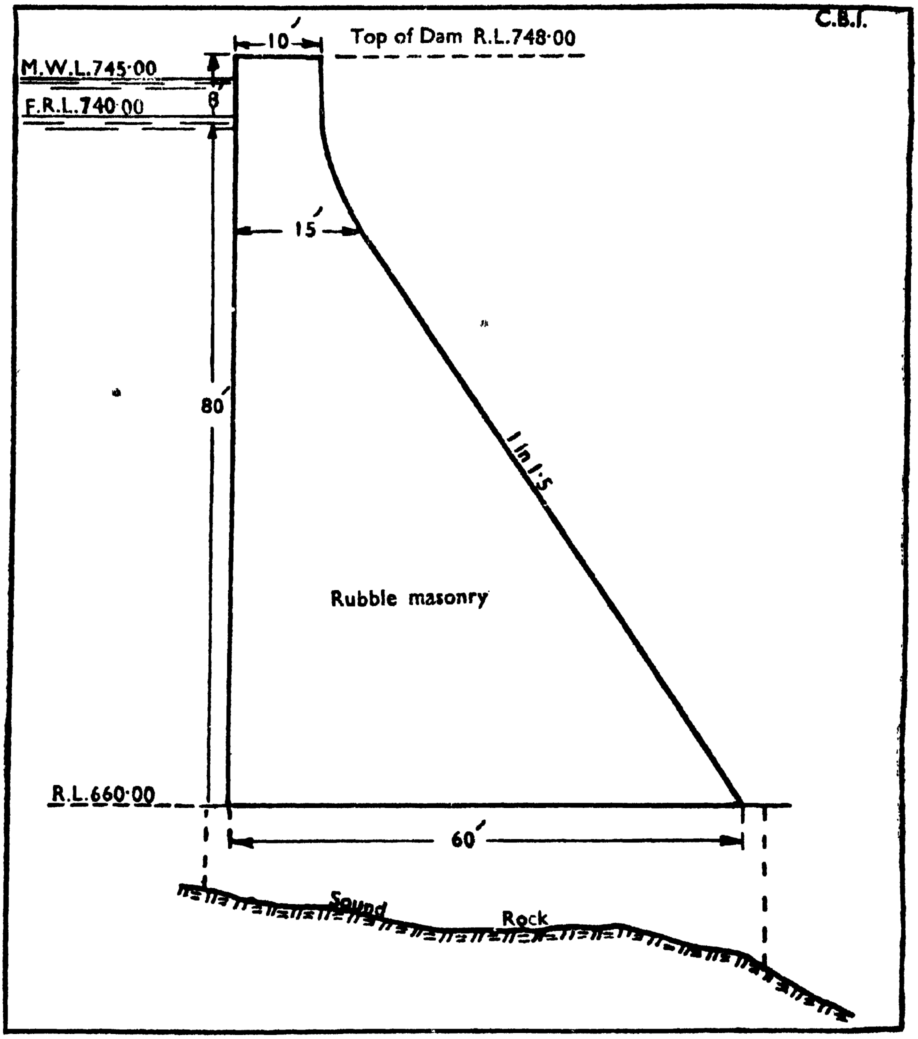
(1) Area of catchment	160 square miles
(2) Nature of catchment	
(3) Mean annual precipitation	
(*a*) Rainfall	28·4 inches
(4) Total average annual yield of the catchment	67,072 acre feet
(5) Climate	Tropical
(6) Temperature conditions and variations	Intense heat in summer and nearly freezing in winter
(7) Rate of Flow	
(*a*) Maximum	
(*b*) Minimum	
(8) Detritus charge of the stream	Water carries considerable quantity of silt
(9) Character (chemical) of the water stored in the reservoir	Turbid with finely divided suspended matter

(10) Geological features	
(*a*) of foundations	Foundations laid on sand stone rocks
(*b*) of catchment area	It consists of bare rocky hillocks and uplands destitute of cultivation
(11) Earthquake (Zone and intensities)	

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M. W. L.	R. L. 745·00
(*b*) F. R. L.	R. L. 740·00
(*c*) Area at M. W. L.	
(*d*) Area at F. R. L.	7·5 square miles
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	
(*b*) Live	100,756·4 acre feet
(*c*) Flood storage	
(*d*) Carry-over	
(3) Maximum height above the lowest point of foundations	82·96 feet
(4) Height above the lowest river bed at dam	79·08 feet
(5) Height of the top of the dam above the crest of the spillway or weir	8 feet
(6) Maximum width at level of foundation	60 feet
(7) Width at top	10 feet
(8) Slopes	As per cross section
(*a*) Upstream	
(*b*) Downstream	
(9) Length at top of the dam	4,400 feet
(*a*) Non-overflow	
(*i*) Main	
(*b*) Spillway	800 feet long with gates
(10) Cubic volume of the body of the dam	6,400,000 cubic feet



Cross section of Tigra Dam

B. OTHERS

(11) Material of which the dam is constructed	Rubble hearting in lime, between face of coursed rubble masonry
(12) Specific gravity	
(*a*) Masonry	2·24
(13) Nature of protection of waterproofing of the upstream and downstream faces	Cement pointing on upstream face

(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundation of the dam	Cement pointing on upstream face
(16) Contraction joints	
(17) Principal stresses in the masonry with a note of methods of calculations employed	
(18) Maximum pressure on foundation	5·5 tons per sq. ft.
(19) Uplift pressure, calculated or measured	
(20) Measures adopted for preventing or counteracting uplift pressures	

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
- (*a*) Crown waste
- (*b*) Proprietory

(2) *Dislocation*
- (*a*) Villages
- (*b*) Families
- (*c*) Population
- (*d*) Roads
    - (*i*) Highways
    - (*ii*) District Roads
    - (*iii*) Village Roads
- (*e*) Railway Lines
- (*f*) Temples, mosques, etc.
- (*g*) Graves, etc.
- (*h*) Trees, gardens, pastures, houses, wells, etc.
- (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Waste weir 800 feet long having 16 tilting gates 10 feet by 4 feet Duncan Straton Automatic Pattern and 64 gates 10 feet by 8 feet Sir Visvesvaryaya Pattern.
(2) Outlet works	Sluice at R. L. 695·00 with opening 2 feet by 3 feet
(3) Scouring works	One scouring sluice 6 feet × 3 feet in river bed.
(4) Inspection facilities	
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	After occurrence of breach in highest portion of the dam due to hydrostatic pressure, the bottom of the section was increased accordingly.
(3) Noteworthy occurrences and accidents	The dam breached in 1918 due to the hydrostatic pressure from the bottom where horizontal and vertical fissures in the sand stone existed, and breach was subsequently restored.
(4) Operation of the dam	
(*a*) Regulation	
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	$3{\cdot}5 \times A$ 3/4 acre feet per year $= 3{\cdot}5 \times 44{\cdot}98 = 157{\cdot}43$ acre feet
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	

(*d*) Various measurements and observations	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	Under such circumstances where there are fissures (vertical and horizontal both) uplift should be taken into account.

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	Investigations for the work were made by Messrs. Collabawala and Shevendas and as per results made out from the investigations by Col. Pitcher, the then Chief Engineer, it was inaugurated by Mr. Sydney Preston, C. I. E. and its construction was started by Mr. E. L. Glass Assistant Engineer of the Punjab Government.
(2) Personnel	Col. Pitcher, Chief Engineer E. L. Glass, Assistant Engineer
(3) Bibliography	

X 13. Majhgawan Dam

(Earthen

I. GENERAL

1. Height above the lowest river bed	55·7 feet
2. Location	Garauli Jagir, Hamirpur district Uttar Pradesh (Gunchi *Nadi*)
3. Authority or owner	Uttar Pradesh Government
4. Purpose —Main and subsidiary	Irrigation
5. Year of commencement	1912
6. Year of completion	1917
7. Capital cost	
(*a*) Estimated	
(*b*) Actual	Rs. 3,68,197
8. Culturable area commanded by the project	22,618 acres
9. Area irrigated	415 acres [average of 10 years (1940—1949)
10. Means of access	(*i*) It is accessible by road via Jaipur village from Belatal railway station distant 10 miles on (Jhansi Manikpur Section) Great Indian Peninsular Railway. The Road is motorable throughout all the year except during the rainy season, when one has to ride. (*ii*) It is 12 miles from the Mowgong *Kacha* district road via Ajmer inspection house, and Tharat distributary of Majhgawan dam.

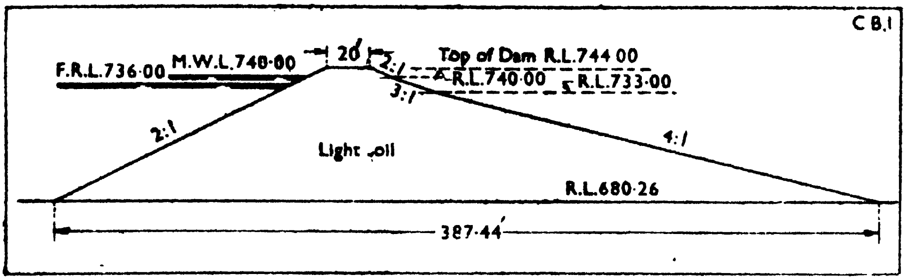
II. GEOPHYSICAL

1. Area of catchment	30·2 sq. miles
2. Nature of catchment	Hilly with very steep slopes
3. Mean annual precipitation	
(*a*) Rainfall	36 inches
(*b*) Snow	
4. Total average annual yield of the catchment	10,050 acre feet.
5. Climate	Dry
6. Temperature conditions and variations	
7. Rate of flow	
(*a*) Maximum	2,917 cusecs
(*b*) Minimum	
8. Detritus charge of the stream	Silting above the dam is very small
9. Character (chemical) of the water stored in the reservoir	
10. Geological features	
(*a*) of foundations	Ordinary Bundelkhand soil, rocky and hard *moorum*
(*b*) of catchment area	
11. Earthquake (Zone and intensities)	There are light tremors, but causing no damage.

III. TECHNICAL.

A. STATISTICAL

1. Reservoir Data	
(*a*) M. W. L.	R. L. 740·00
(*b*) F. R. L.	R. L. 735·00
(*c*) Area at M. W. L.	
(*d*) Area at F. R. L.	3·20 square miles
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
2. Capacity of the reservoir	
(*a*) Gross	22423·37 acre feet
(*b*) Live	21,717·17 acre feet
(*c*) Flood Storage	10,050·00 acre feet
(*d*) Carry over	12,373·37 acre feet



Cross section of the Majhgawan Dam.

3. Maximum height above the lowest point of foundations	72·88 feet
4. Height above the lowest river bed at dam	55·7 feet
5. Height of the top of the dam above the crest of the spillway or weir	8 feet
6. Maximum width at level of foundations	387·44 feet
7. Width at top	20 feet
8. Slopes	
(*a*) Upstream	2 : 1
(*b*) Downstream	2 : 1, 3 : 1 and 4 : 1
9. Length at top of the dam	
(*a*) Non-overflow	
(*i*) Main	4,310 feet including two portions
(*ii*) Subsidiary	4,020 feet
(*b*) Spillway or weir	290 feet
10. Cubic volume of the body of the dam	13,485,000 cubic feet

B. OTHERS

11. Material of which the dam is constructed	Light soil
12. Specific gravity	
(*c*) Rockfill	
(*d*) Earthfill	
13. Nature of protection and water proofing of the upstream and downstream faces	Upstream face pitched with dry stones up to H.F.L. and a core-wall provided in *Nadi* Section.

(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundation of the dam	Rubble stone masonry core-wall in the centre of the *bund* carried to the depth of sand layer
(22) Particular of the berm (if any) width and position	
(23) Position and form of the core-wall (or other means of securing water tightness)	Corewall is in the centre of the *bund* and vertical stepped wall rubble stone masonry formed over a lime concrete foundation
(24) Batter (if any) of the core-wall	1 in 6 (with steps)
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	19·52 feet
(26) Method of keying core-wall or other wall in the underlying ground	By trenching rubble stone masonry on lime concrete carried below ground level through sand layer
(27) Nature of material forming the core or other wall.	

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) Land submerged :	1978 Acres
(a) Crown waste	
(b) Proprietory	
(2) Dislocation :	
(a) Villages	Not affected
(b) Families	
(c) Population	
(d) Roads :	
(i) Highways	
(ii) District Roads	
(iii) Village Roads	
(e) Railway Lines	
(f) Temples, Mosques, etc.	
(g) Graves, etc.	
(h) Trees, Gardens, Pastures, Houses, Wells, etc.	
(i) Bridges	
(3) Compensation paid under each category of item (2)	
(4) Method of compensating for land of dispossessed landholders	

V. AUXILIARY WORKS

(1) Surplussing works	The dam is provided with a weir 290 feet in length and designed to discharge 6,417 cusecs up to a water depth of 3·5 feet above the crest at R. L. 736·00 clear overall, the previous actual discharge is 2,917 cusecs
(2) Outlet works	Two sluices of the canal size of aperture is 2′×2′ and 3′×3·1′
(3) Scouring works	
(4) Inspection facilities	
(5) Fish pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional	All construction was done by manual labour
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurrences and accidents	
(4) Operation of the dam	
(*a*) Regulation	
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	
(*d*) Various measurements and observations	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	

(*iv*) Seepage and regeneration

(*e*) Fish culture

(*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	The construction of the dam was started in 1912 and was completed in 1917 at a total cost of Rs. 3,68,197
(2) Personnel	1. Mr. F. Anderson, Executive Engineer 2. Mr. M. A. Higgs, Assistant Engineer
(3) Bibliography	

X. 14. Ghagar Main Dam

(Masonry)

I. GENERAL

(1) Height above the lowest river bed	67 feet
(2) Location	Mirzapur District, Uttar Pradesh (Ghagar *Nadi*)
(3) Authority or owner	Uttar Pradesh Government
(4) Purpose Main and subsidiary	Irrigation
(5) Year of commencement	1913
(6) Year of completion	1917
(7) Capital cost	
(*a*) Estimated	39,77,863
(*b*) Actual	42,73,314
(8) Culturable area commanded by the project	202,252 acres
(9) Area irrigated	70,000 acres
(11) Means of access	Nearest Railway station Mirzapur. From Mirzapur to Robutsganj Provincial road and from Robutsganj to the Dam site a fair weather road

II. GEOPHYSICAL

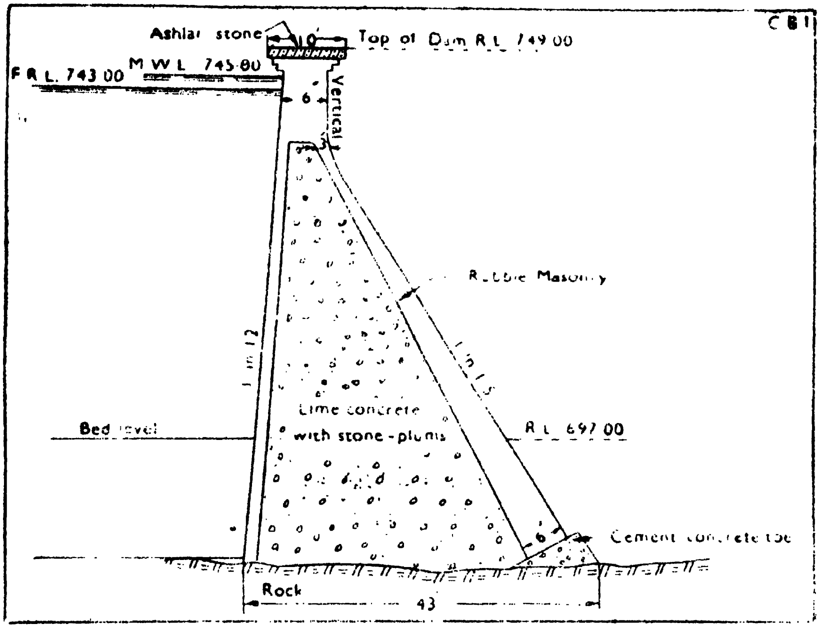
(1) Area of catchment	110 square miles
(2) Nature of catchment	Hilly with steep slopes and covered with jungle
(3) Mean annual precipitation—	
(*a*) Rainfall	47 inches
(4) Total average annual yield of the catchment	155,785 acre feet
(5) Climate	Hot
(6) Temperature conditions and variations	Maximum temperature—115°F Minimum temperature—40°F

(7) Rate of Flow	
(a) Maximum	9,725 cusecs
(b) Minimum	
(8) Detritus charge of the stream	It is generally silt laden and muddy in the flood season
(9) Character (chemical) of the water stored in the reservoir	Hard
(10) Geological features	
(a) of foundations	Foundations are mostly on sand stone
(b) of catchment area	mostly hilly covered with jungle and partly steep slopes and with metal

III. TECHNICAL

A.—STATISTICAL

(1) Reservoir Data	
(a) M. W. L.	R. L. 745·00
(b) F. R. L.	R. L. 743·00
(c) Area at M. W. L.	7,767 acres
(d) Area at F. R. L.	7,495 acres
(e) Maximum length	4·5 miles
(f) Maximum width	3·5 miles
(g) Length of periphery	18·5 miles
(2) Capacity of the reservoir	
(a) Gross	123,655 acre feet
(b) Live	120,809 acre feet
(c) Flood storage	15,032 acre feet
(d) Carry-over	
(3) Maximum height above the lowest point of foundations	68·26 feet
(4) Height above the lowest river bed at dam	67 feet
(5) Height of the top of the dam above the crest of the spillway or weir	5 feet
(6) Maximum width at level of foundation	43 feet
(7) Width at top	8 feet



Cross Section of Ghagar Main Dam

8) **Batter** of face slopes	
(*a*) Upstream	1 in 12
(*b*) Downstream	1 in 1·5 and vertical
(9) **Length** at top of the dam	2,283 feet
(*a*) Non-overflow	
(*i*) Main	1,059 feet
(*b*) Spillway or weir (Waterweirs)	1,224 feet
10) **Cubic** volume of the body of the **dam**	204,853,160 cubic feet

B. OTHERS

(11) **Material** of which the dam is con**structed**	Rubble stone masonry **in lime for facing** and lime concrete **with stone** plums for hearting
(12) **Specific** gravity	
(*a*) Masonry	150 lb.
(*b*) Concrete	140 lb.
(13) **Nature** of protection and water**proofing** of the upstream and down**stream** faces	Cement pointing
(14) **Provision** for dealing with seepage **and drainage** water	Seepage drain below the downstream toe of bunds

(15) Means of securing water tightness of the foundation of the dam	Cement grouting
(16) Contraction joints	
(17) Principal stresses in the masonry with a note of methods of calculations employed	
(18) Maximum pressure on foundations	
(19) Uplift pressure, calculated or measured	
(20) Measures adopted for preventing or counteracting uplift pressures	

V. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*	
(*a*) Crown waste	About 70% of the total land submerged
(*b*) Proprietory	About 30% of the total land submerged.
(2) *Dislocation*	
(*a*) Villages	
(*b*) Families	
(*c*) Population	
(*d*) Roads	
(*i*) Highways	
(*ii*) District Roads	
(*iii*) Village Roads	
(*e*) Railway Lines	
(*f*) Temples, mosques, *etc.*	One Temple
(*g*) Graves, *etc.*	None
(*h*) Trees, gardens, pastures, houses, wells, etc.	Trees submerged in the reservoir were cut ; gardens, pastures, houses and wells of some villages were all submerged
(*i*) Bridges	One bridge on Ghagar nadi was submerged
(3) Compensation paid under each category of item (2)	Rs. 85,400
(4) Method of compensating for land of dispossessed landholders	Emergent land from reservoir was leased out to dispossessed landholders for *rabi* : Cultivators of land which was submerged in the reservoir, were paid in cash

V. GEOPHYSICAL

(1) Surplussing works	It is provided with three escapes *viz.*, Main escape 484 feet in length, Escape No. 1. 12 spans of 20 feet each and Escape No 2 is 500 feet in length and can discharge 40,000 cusecs maximum.
(2) Outlet works	Two canal head sluice gates each 6 feet by 6 feet
(3) Scouring works	One *nadi* sluice 2·5 feet by 4 feet
(4) Inspection facilities	Road on top of afflux bund and upto the main dam
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	All masonry concrete and earth work except some earth work in digging reach of the cut was done by manual labour. Machinery was used to cut the channel where it was in deep digging
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurrences and accidents	
(4) Operation of the dam	Water level in the reservoir is maintained through escape No. 1 which has 12 gates of 20 feet each at a lower level than the F. R. L. of the water
(*a*) Regulation	
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	Since 1916 to 1945 about 240 million cubic feet of silt has been deposited in the reservoir
(*ii*) Rate of silting	8 million cubic feet per year or 2·5 million cubic feet per 100 square miles of catchment area every year

(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	2·5 million cubic feet per 29 acre miles of catchment as against 1·9 million cubic feet as anticipated
(*d*) Various measurements and observations	
(*i*) Evaporation losses	0·02 to 0·04 foot per day
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	Leakage through the fissures under the main Dam varies from 10 to 30 cusecs
(*e*) Fish culture	
(*f*) Anti-malaria measures	Pits drained
(5) Recreation facilities	Boating arrangements
(6) Lessons to be learnt from the construction and utilisation of the dam	Rubble stone masonry should be done instead of plums concrete for hearting to minimise leakage through dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	The dam was constructed during 1912- 18
(2) Personnel	1. Mr. B. D'o Darley—Executive Engineer 2. Mr. T. M. Lyle—Assistant Engineer 3. Mr. F. H. Hutchinson—Assistant Engineer 4. Mr. Mohsin Ali—Assistant Engineer 5. Mr. S. P. Tandon—Assistant Engineer 6. Pt. Behari Lal—Assistant Engineer
(3) Bibliography	

X. 15. Khaptia Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	54·22 feet
(2) Location	Banda district, Uttar Pradesh (Jhota *Nadi*)
(3) Authority or owner	Uttar Pradesh Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1912
(6) Year of completion	1912
(7) Capital cost	
(*a*) Estimated	Rs. 1,19,649
(*b*) Actual	Rs. 1,22,292
(8) Culturable area commanded by the project	3,924 acres
(9) Area irrigated	331 acres
(11) Means of access	It is accessible from Bargarh Railway Station (Great Indian Peninsular Railway) on Bargarh-Man district *kacha* Road about five miles and then *via* Babri Canal inspection house which is about two miles to the left. The dam is situated near Babri Inspection house.

II. GEOPHYSICAL

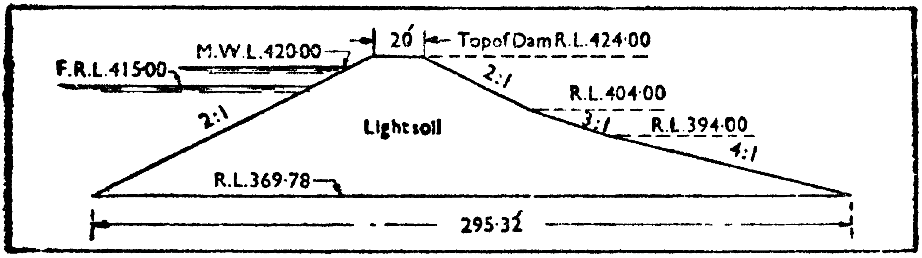
(1) Area of catchment	4·46 square miles
(2) Nature of catchment	Hilly
(3) Mean annual precipitation	
(*a*) Rainfall	36 inches
(4) Total average annual yield of the catchment	1,882·46 acre feet.

(5) Climate	Dry
(6) Temperature conditions and variations	
(7) Rate of flow	
(*a*) Maximum	
(*b*) Minimum	
(8) Detritus charge of the stream	No charge
(9) Character (chemical) of the water stored in the reservoir	Clear except in flood season
(10) Geological features	
(*a*) of foundations	Ordinary light Bundelkhand soil
(*b*) of catchment area	
(11) Earthquake (Zone and intensities)	There are light tremors, but causing no damage

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M.W.L.	R.L. 420·00
(*b*) F.R.L.	R.L. 41·500
(*c*) Area at M.W.L.	
(*d*) Area at F.S.L.	0·66 square mile
(*e*) Maximum length	1·25 miles
(*f*) Maximum width	One mile
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	4,889·80 acre feet
(*b*) Live	4,820·93 acre feet
(*c*) Flood storage	4889·80 acre feet



Cross Section of the Khaptia Dam

(3) Maximum height above the lowest point of foundations	52·22 feet
(4) Height above the lowest river bed at dam	52·22 feet

(5) Height of the top of the dam above the crest of the spillway or weir	9 feet
(6) Maximum width at level of foundation	295·32 feet
(7) Width at top	20 feet
(8) Slopes	
(a) Upstream	2 : 1
(b) Downstream	2 : 1, 3 : 1, and 4 : 1
(9) Length at top of the dam	1,673 feet
(a) Non overflow	
(i) Main	1,523 feet
(b) Spillway or weir	150 feet
(10) Cubic volume of the body of the dam	6,768,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Light soil
(12) Specific gravity	
(d) Earthfill	
(13) Nature of protection and water proofing of the upstream and downstream faces	Light soil except at ends where it abuts on hillocks. Upstream face is pitched with one foot stone upto one foot above M.W.L. Downstream toe of *nala* is protected with one foot stone pitching.
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundation of the dam	
(22) Particular of the berm (if any) width and position	No berm

17. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*

(a) Crown waste

(b) Proprietory

(2) *Dislocation*
- (*a*) Villages
- (*b*) Families
- (*c*) Population
- (*d*) Roads
  - (*i*) Highways
  - (*ii*) District Roads
  - (*iii*) Village Roads
- (*e*) Railway Lines
- (*f*) Temples, mosques, etc.
- (*g*) Graves, etc.
- (*h*) Trees, gardens, pastures, houses, wells, etc.
- (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplusing works	The dam is provided with a **masonry escape 150 feet in length, designed** to discharge 6,638 cusecs upto **water** depth of 5 feet above the **crest at** R.L. 415.00.
(2) Outlet works	Canal sluice size of aperture 1·5 **feet** × 1·5 feet
(3) Scouring works	
(4) Inspection facilities	
(5) Fish pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	All work was done by manual **labour**
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurrences and accidents	

(4) Operation of the dam
  (*a*) Regulation
  (*b*) Silting of the reservoir
    (*i*) Total silt deposited
    (*ii*) Rate of silting
    (*iii*) Density of the silt deposited
    (*iv*) Rate of advancement of delta
  (*c*) Actual yield as against estimated
  (*d*) Various measurements and observations
    (*i*) Evaporation losses
    (*ii*) Sweating below the dam
    (*iii*) Temperature measurements
    (*iv*) Seepage and regeneration
  (*e*) Fish culture
  (*f*) Anti-malaria measures
(5) Recreation facilities
(6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	The scheme for Khaptia dam was recommended by Mr. C. A. Silberrad Collector of Banda in 1904-05. Later on Mr. F. F. Bion, Executive Engineer took the scheme in hand. The estimate sanctioned was in 1912 and the dam was completed in 1919 at a total cost of Rs. 1,22,292/-.
(2) Personnel	1. Mr. H. Laue, Executive Engineer 2. L. N. Misra, Assistant Engineer
(3) Bibliography	

X. 16. Magarpur Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	34·35 feet
(2) Location	Jhansi District, Uttar Pradesh (Mino River)
(3) Authority or owner	Uttar Pradesh Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1914
(6) Year of completion	1920
(7) Capital cost	
(*a*) Estimated	
(*b*) Actual	
(8) Culturable area commanded by the project	
(9) Area irrigated	
(11) Means of access	

II. GEOPHYSICAL

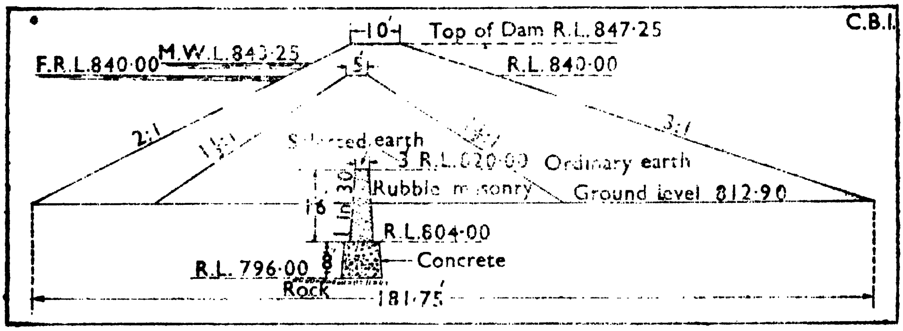
(1) Area of catchment	4·75 square miles
(2) Nature of catchment	Hills covered with jungle and little cultivation
(3) Mean annual precipitation	
(*a*) Rainfall	33 inches
(4) Total average annual yield of the catchment	18,823 acre feet
(5) Climate	Sub-tropical
(6) Temperature conditions and variations	Maximum temperature 115°F Minimum temperature 40°F
(7) Rate of Flow	
(*a*) Maximum	4250 cusecs
(*b*) Minimum	No flow

(8) Detritus charge of the stream	It is generally silt laden and muddy during the flood season
(9) Character (chemical) of the water stored in the reservoir	
(10) Geological features	
(*a*) of foundations	Earth
(*b*) of catchment area	
(11) Earthquake (Zone and intensities)	

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M.W.L.	R.L. 843·25
(*b*) F.R.L.	R.L. 840·00
(*c*) Area at M.W.L.	
(*d*) Area at F.R.L.	0·089 square mile
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	
(*b*) Live	1,997 acre feet
(*c*) Flood storage	
(*d*) Carry-over	



Cross Section of Magarpur Dam

(3) Maximum height above the lowest point of foundations	51·25 feet
(4) Height above the lowest river bed at dam	34·35 feet

(5) Height of the top of the dam above the crest of the spillway or weir	7·25 feet
(6) Maximum width at level of foundation	181·75 feet
(7) Width at top	10 feet
(8) Slopes	
(*a*) Upstream	2 : 1
(*b*) Downstream	3 : 1
(9) Length at top of the dam	2,486 feet
(*a*) Non-overflow	
(*i*) Main	2,036 feet
(*b*) Spillway or weir	450 feet
(10) Cubic volume of the body of the dam	

B. OTHERS

(11) Material of which the dam is constructed	Rankar earth
(12) Specific gravity	
(*d*) Earthfill	
(13) Nature of protection and water-proofing of the upstream and downstream faces	
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundation of the dam	By means of masonry corewall on concrete
(16) Contraction joints	
(17) Principal stresses in the masonry with a note of methods of calculation employed	
(18) Maximum pressure on foundations	
(19) Uplift pressure, calculated or measured	
(20) Measures adopted for preventing or counteracting uplift pressures	
(21) Hydraulic gradient for which the embankment is designed	
(22) Particular of the berm (if any) width and position	No berm

(23) Position and form of the core-wall (or other means of securing water tightness)	As per cross section
(24) Batter (if any) of the core wall	1 in 30
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	16·90 feet
(26) Method of keying core-wall or other wall in the underlying ground	By means of trenching
(27) Nature of material forming the core or other wall	Rubble stone masonry and concrete

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory
(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads
    (*i*) Highways
    (*ii*) District Roads
    (*iii*) Village Roads
  (*e*) Railway Lines
  (*f*) Temples, mosques, etc.
  (*g*) Graves, etc.
  (*h*) Trees, gardens, pastures, houses, wells, etc.
  (*i*) Bridges
(3) Compensation paid under each category of item (2)
(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplusing works	The dam is provided with a spillway 450 feet in length with a maximum discharging capacity of 6,130 cusecs
(2) Outlet works	One canal sluice one foot by one foot
(3) Scouring works	

(4) Inspection facilities

(5) Fish-pass

(6) Means for dissipating energy below the spillway

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the dam

  (*a*) Regulation

  (*b*) Silting of the reservoir

    (*i*) Total silt deposited

    (*ii*) Rate of silting

    (*iii*) Density of the silt deposited

    (*iv*) Rate of advancement of delta

  (*c*) Actual yield as against estimated

  (*d*) Various measurements and observations

    (*i*) Evaporation losses

    (*ii*) Sweating below the dam

    (*iii*) Temperature measurements

    (*iv*) Seepage and regeneration

  (*e*) Fish culture

  (*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

R. B. Lala Madan Gopal Sardhana
Executive Engineer

(3) Bibliography

X. 17. Barwar Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	62·54 feet
(2) Location	Jhansi district, Uttar Pradesh (Baura *Nadi*)
(3) Authority or owner	Uttar Pradesh Government
(4) Purpose-main and subisidiary	Irrigation
(5) Year of commencement	1914
(6) Year of completion	1923
(7) Capital cost	
(*a*) Estimated	
(*b*) Actual	
(8) Culturable area commanded by the project	
(9) Area irrigated	
(11) Means of access	The lake is situated 58 miles from Jhansi and is accessible by motorable road It is approached by the nearest Ranipur Railway Station, on the Jhansi Manikpur branch (Great Indian Peninsular Railway)

II. GEOPHYSICAL

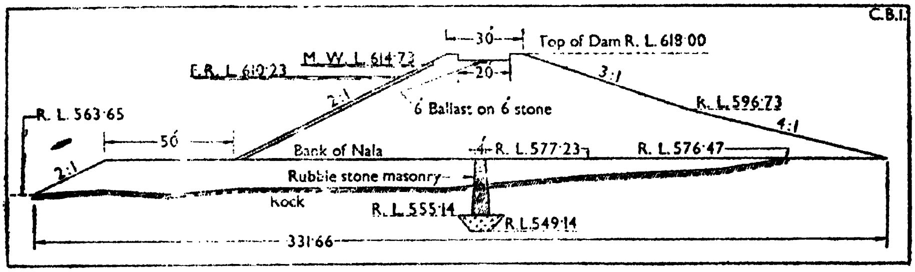
(1) Area of catchment	65 square miles
(2) Nature of catchment	Catchment is flat and partly under cultivation
(3) Mean annual precipitation	
(*a*) Rainfall	31 inches
(4) Total average annual yield of the catchment	

(5) Climate	Sub tropical
(6) Temperature conditions and variations	Maximum temperature 115°F Minimum temperature 40°F
(7) Rate of Flow	
(a) Maximum	22,200 cusecs
(b) Minimum	No flow
(8) Detritus charge of the stream	It is generally silt laden and muddy during the flood season
(9) Character (chemical) of the water stored in the reservoir	It is clear, except during monsoon period
(10) Geological features	
(a) of foundations	Partly on earth and partly on rock
(b) of catchment area	Almost rocky
(11) Earthquake (Zone and intensities)	Infrequent

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(a) M.W.L.	R.L. 614·73
(b) F.R.L.	R.L. 610·23
(c) Area at M.W.L.	
(d) Area at F.R.L.	3·88 square miles
(e) Maximum length	
(f) Maximum width	
(g) Length of periphery	
(2) Capacity of the reservoir	
(a) Gross	
(b) Live	27,388 acre feet
(c) Flood storage	
(d) Carry-over	



Cross Section of Barwar Dam.

Maximum height above the lowest oint of foundations	69·9 feet

(4) Height above the lowest river bed at dam	62·54 feet
(5) Height of the top of the dam above the crest of the spillway or weir	7·9 feet
(6) Maximum width at level of foundation	331·66 feet Overall breadth 30 feet
(7) Width at top	Road way—20 feet
(8) Slopes	
(*a*) Upstream	2 : 1
(*b*) Downstream	3 : 1 and 4 : 1
(9) Length at top of the dam	3, 668 feet
(*a*) Non-overflow	
(*i*) Main	3,248 feet
(*b*) Spillway or weir	420 feet
(10) Cubic volume of the body of the dam	

B. OTHERS

(11) Material of which the dam is constructed	Parwa and Rankar earth
(12) Specific gravity	
(*d*) Earthfill	
(13) Nature of protection and waterproofing of the upstream and downstream faces	Upstream slope pitched with stones
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundation of the dam	By means of rubble stone masonry core-wall founded on concrete
(21) Hydraulic gradient for which the embankment is designed	
(22) Particulars of the berm (if any) width and position	
(23) Position and form of the core-wall (or other means of securing water tightness)	As per cross section
(24) Batter (if any) of the core-wall	1 in 15
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	11·65 feet
(26) Method of keying core-wall or other wall in the underlying ground	By means of rubble stone masonry corewall on concrete bed

(27) Nature of material forming the core or other wall	Rubble stone masonry on concrete

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*

- (*a*) Crown waste
- (*b*) Proprietory

(2) *Dislocation*

- (*a*) Villages
- (*b*) Families
- (*c*) Population
- (*d*) Roads
  - (*i*) Highways
  - (*ii*) District Roads
  - (*iii*) Village Roads
- (*e*) Railway Lines
- (*f*) Temples, mosques, etc.
- (*g*) Graves, etc.
- (*h*) Trees, gardens, pastures, houses, wells, etc.
- (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplusing works	Spillway 420 feet in length, maximum discharging capacity of 27,300 cusecs
(2) Outlet works	One canal sluice 3 feet by 3 feet
(3) Scouring works	

(4) Inspection facilities	
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII—SUPPLEMENTARY INFORMATION

(1) Constructional features	The work was partly done by manual labour and partly by tip trucks pushed by hands
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
3) Noteworthy occurrences and accidents	
(4) Operation of the dam	
(*a*) Regulation	
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	
(*d*) Various measurements and observations	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	
(5) Recreation facilities	
6) Lessons to be learnt from the construction and utilisation of the dam	

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	
(2) Personnel	Rai Bahadur Madan Gopal Sardhana.
(3) Bibliography	

X. 18. Bornia Upper Dam

(Masonry)

I GENERAL

(1) Height above the lowest river bed	69 feet
(2) Location	Jubbalpur Distt. (Madhya Pradesh.
(3) Authority or owner	Madhya Pradesh Government
(4) Purpose—Main and Subsidiary	Irrigation
(5) Year of commencement	1914
(6) Year of completion	1923
(7) Capital cost	
(*a*) Estimated	Rs. 5,31,998 upper and lower dam
(*b*) Actual	Rs. 6,72,824 (head works only) Upper and lower dam.
(8) Culturable area commanded by the project	2,488 acres
(9) Area irrigated (*kharif*)	421 acres
(11) Means of access	It is accessible by road from Salaia Railway Station on the Great Indian Peninsular Railway, which is 6 miles away from the dam site.

II GEOPHYSICAL

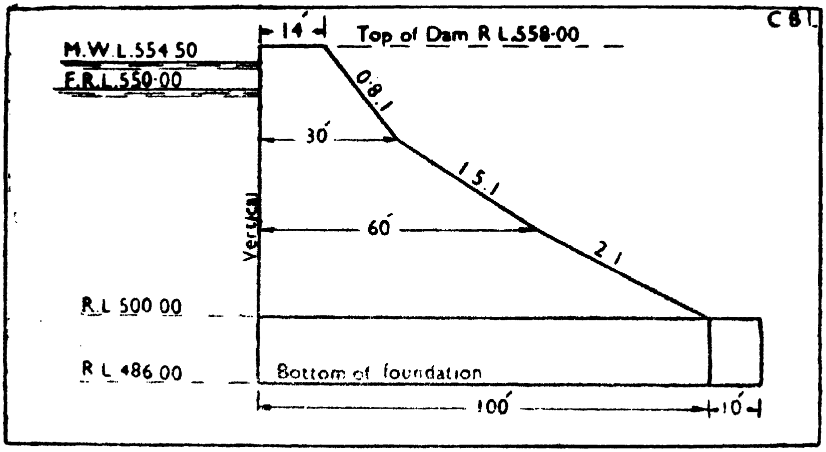
(1) Area of catchment	14·4 square miles of upper Dam
(2) Nature of catchment	Hilly with jungle and steep slope
(3) Mean annual precipitation	
(*a*) Rainfall	44·51 inches
(4) Total average annual yield of the catchment	17,332 acre feet
(5) Climate	Temperate
(6) Temperature conditions and variations	Maximum temperature 116°F and variation 20°F mean

(7) Rate of Flow	
(*a*) Maximum	
b) Minimum	
(8) Detritus charge of the stream	It is clear for eight months and silt laden for four months during rainy season.
(9) Character (chemical) of the water stored in the reservoir	
(10) Geological features	
(*a*) of foundations	Vidhyan sand stone
(*b*) of catchment area	Mostly *moorum*

III TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M. W. L.	R. L. 554·50
(*b*) F. R. L.	R. L. 550·00
(*c*) Area at M. W. L.	0·11 square mile
(*d*) Area at F. R. L.	0·108 square mile
(*e*) Maximum length	0·84 mile
(*f*) Maximum width	0·75 mile
(*g*) Length of periphery	2·8 miles
(2) Capacity of the reservoir	
(*a*) Gross	1351 acre feet
(*b*) Live	1240 acre feet (available)
(*c*) Flood storage	310 acre feet
(*d*) Carry-over	410 acre feet



Cross Section of Bornia Upper Dam

(3) Maximum height above the lowest point of foundations	74 feet
(4) Height above the lowest river bed at dam	69 feet
(5) Height of the top of the dam above the crest of the spillway or weir	8 feet and 5 feet
(6) Maximum width at level of foundations.	100 feet
(7) Width at top	6 feet at crest of arch ring and 14 feet at top of pier
(8) Batter of face slopes	
(*a*) Upstream	Vertical
(*b*) Downstream	2 : 1, 1·5 : 1, 8 : 1
(9) Length at top of the dam	
(*a*) Non-overflow	
(*i*) Main	1,041 feet
(*ii*) Subsidiary	351 feet
(*b*) Spillway	690 feet
(10) Cubic volume of the body of the dam	2,575,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	The faces of the dam have been constructed of coursed rubble masonry the hearting being of plum-concrete and the upstream face built in cement mortar for a depth of six inches from the face.
(12) Specific gravity	
(*a*) Masonry	2·0
(*b*) Concrete	
(13) Nature of protection water proofing of the upstream and downstream faces	Cement pointing
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundations of the dam	Cement pointing
(16) Contraction joints	
(17) Principal stresses in the masonry with a note of methods of calculations employed	Vertical and horizontal resultant pressure determined for over 20 feet height
(18) Maximum pressure on foundations	3·6 tons per square foot

19) Uplift pressure, calculated or measured	
(20) Measures adopted for preventing or counteracting uplift pressures	

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land Submerged*	
(*a*) Crown waste	
(*b*) Proprietory	
(2) *Dislocation*	
(*a*) Villages	
(*b*) Families	
(*c*) Population	
(*d*) Roads	
(*i*) Highways	
(*ii*) District Roads	
(*iii*) Village Roads	
(*e*) Railway Lines	
(*f*) Temples, mosques, *etc.*	
(*g*) Graves, *etc.*	
(*h*) Trees, gardens pastures, houses, wells, etc.	
(*i*) Bridges	
(3) compensation paid under each category of item (2)	Not known.
(4) Method of compensating for land of dispossessed landholders	By cash payment.

V. AUXILIARY WORKS

1) Surplussing works	The length of weir is 230·0 feet at R. L. 550·0 and 460·0 feet at R. L. 553·0. Total length comes to 690 feet and its discharging capacity is 10,000 cusecs.
(2) Outlet works	Sluice gate of penstock pattern 2·0 feet × 3·0 feet .
(3) Scouring works	
(4) Inspection facilities	Sluice can be inspected when the tank is empty
(5) Fish-pass	
6) Means for dissipating energy below the spillway	The spillway has a rocky bed with slopes.

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	Work was done by skilled manual labour.
(2) Changes introduced in the plans of the dams and in the method of carrying out the work	The main dam was reduced in height by 25 feet the storage capacity of the reservoir was thus reduced from 3,603 acre feet to 1,354 acre feet. Lower dam of earth with masonry flank weir was constructed with available storage capacity of 413 acre feet.
(3) Note-worthy occurrences and accidents.	
(4) Operation of the dam	
(*a*) Regulation	Through hand operated sluice gear
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	17,322 acre feet against 14,452 acre feet estimated.
(*d*) Various measurements and observations.	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	There is some
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	There is slight leakage; regeneration not known as there is earthen dam lower.
(*e*) Fish Culture	
(*f*) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

(2) Personnel

(3) Bibliography

X. 19. Amahi Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	53 feet
(2) Location	Isagarh District, Madhya Bharat Union (Tributary Nala of Orr river)
(3) Authority or owner	Madhya Bharat Union
(4) Purpose—Main and Subsidiary	Irrigation
(5) Year of commencement	1912
(6) Year of completion	1925
(7) Capital cost	
(*a*) Estimated	Rs. 3,07,852
(*b*) Actual	Rs. 2,69,370
(8) Culturable area commanded by the project	
(9) Area irrigated	
(11) Means of access	

II. GEOPHYSICAL

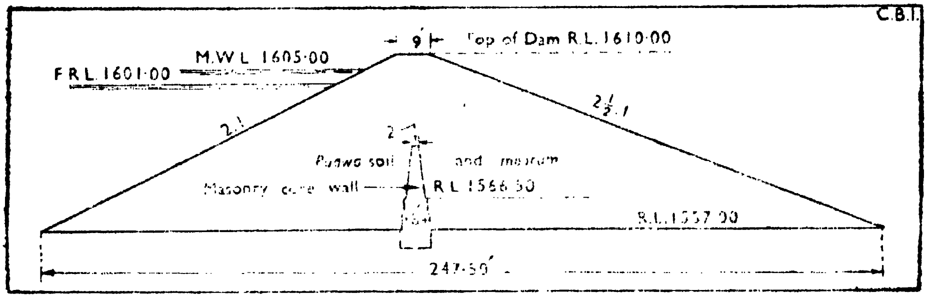
(1) Area of catchment	20·7 square miles
(2) Nature of catchment	Hilly country
(3) Mean annual precipitation	
(*a*) Rainfall	35·1 inches
(*b*) Snow	
(4) Total average annual yield of the catchment	10,579 acre feet
(5) Climate	Tropical
(6) Temperature conditions and variations	Intense heat in summer and near freezing in winter
(7) Rate of Flow	
(*a*) Maximum	
(*b*) Minimum	

(8) Detritus charge of the stream	
9) Character (chemical) of the water stored in the reservoir	Turbid with finely divided suspended matter
(10) Geological features	
(a) of foundations	Embankments are on Padwa soil *moorum* and boulders.
(b) of catchment area	
(11) Earthquake (Zone and intensities)	Hilly country and of *Padwa* and black cotton soil and boulders

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(a) M. W. L.	R. L. 1605·00
(b) F. R. L.	R. L. 1601·00
(c) Area at M. W. L.	1·25 square miles
(d) Area at F. R. L.	
(e) Maximum length	
(f) Maximum width	
(g) Length of periphery	
(2) Capacity of the reservoir	
(a) Gross	
(b) Live	10,207 acre feet
(c) Flood storage	
(d) Carry-over	



Cross Section of Amahi Dam

(3) Maximum height above the lowest point of foundations	59 feet
(4) Height above the lowest river bed at dam	53 feet
(5) Height of the top of the dam above the crest of the spillway or weir	9 feet

(6) Maximum width at level of foundation	247·5 feet
(7) Width at top	9 feet
(8) Slopes	
(a) Upstream	2 : 1
(b) Downstream	2½ : 1
(9) Length at top of the dam	8,300 feet
(a) Non-overflow	
(i) Main	7,950 feet
(b) Spillway	350 feet
(10) Cubic volume of the body of the dam	13,410,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	*Padwa* soil and *moorum*
(12) Specific gravity (d) Earthfill	
(13) Nature of protection and waterproofing of the upstream and downstream faces	
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundation of the dam	By masonry core-wall
(16) Hydraulic gradient for which the embankment is designed	
(17) Particulars of the berm (if any) width and position	
(18) Position and form of the core wall (or other means of securing water tightness)	As per cross section
(19) Batter (if any) of the core wall	1 in 8
(20) Maximum depth below ground surface of core wall or other means of securing water tightness	6 feet
(21) Method of keying core-wall or other wall in the underlying ground	
(22) Nature of material forming the core or other wall	

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory

(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  c) Population
  (*d*) Roads
    (*i*) Highways
    (*ii*) District Roads
    (*iii*) Village Roads
  (*e*) Railway Lines
  (*f*) Temples, mosques, etc.
  (*g*) Graves, etc.
  (*h*) Trees, gardens, pastures, houses, wells, etc.
  (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Waste weir 350 feet long, discharge 10,200 cusecs
(2) Outlet works	One gate 2 feet by 2·5 feet
(3) Scouring works	
(4) Inspection facilities	
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying out the work

(3) Noteworthy occurrences and accidents

(4) Operation of the dam
  - (*a*) Regulation
  - (*b*) Silting of the reservoir
    - (*i*) Total silt deposited
    - (*ii*) Rate of silting
    - (*iii*) Density of the silt deposited
    - (*iv*) Rate of advancement of delta
  - (*c*) Actual yield as against estimated.
  - (*d*) Various measurements and observations
    - (*i*) Evaporation losses
    - (*ii*) Sweating below the dam
    - (*iii*) Temperature measurements
    - (*iv*) Seepage and regeneration
  - (*e*) Fish culture
  - (*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	
(2) Personnel	Mr. Sydney Preston C.I.E.
(3) Bibliography	

X. 20. Pagara Dam

Composite (Masonry and Earthen)

I. GENERAL

(1) Height above the lowest river bed	Masonry portion 74 feet Earthen portion 89·4 feet
(2) Location	Tawarghar District, Madhya Bharat Union, Asan river
(3) Authority or owner	Madhya Bharat Union
(4) Purpose—Main and Subsidiary	Irrigation
(5) Year of commencement	1911
(6) Year of completion	1927
(7) Capital cost	
(a) Estimated	Rs. 20,12,122
(b) Actual	Rs. 20,00,000
(8) Culturable area commanded by the project	
(9) Area irrigated	
(11) Means of access	

II. GEOPHYSICAL

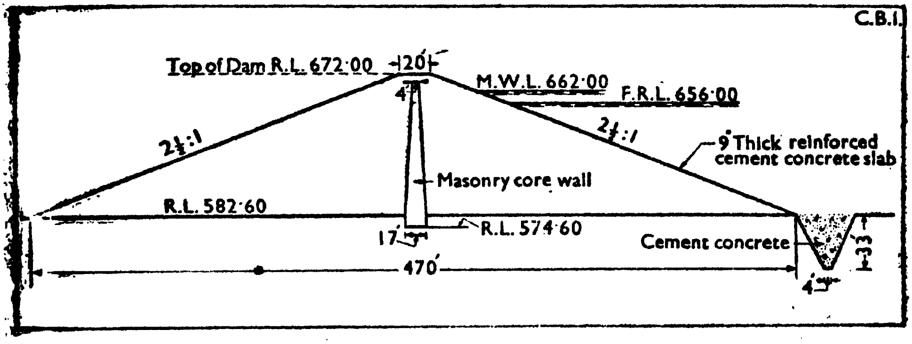
(1) Area of catchment	200 square miles
(2) Nature of catchment	
(3) Mean annual precipitation	
(a) Rainfall	29 inches
(b) Snow	
(4) Total average annual yield of the catchment	82,719 acre feet
(5) Climate	Tropical
(6) Temperature conditions and variations	Intense heat in summer and nearly freezing in winter

(7) Rate of flow	
(*a*) **Maximum**	
(*b*) **Minimum**	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	Turbid with finely divided suspended matter
(10) Geological features	
(*a*) of foundations	Foundation of embankment—boulders Kopra, *moorum* Foundation of dam—in fissured rock.
(*b*) of catchment area	Catchment area is of waste ravines and cultivated land and partially it is hilly.
(11) Earthquake (Zone and intensities)	

III. TECHNICAL

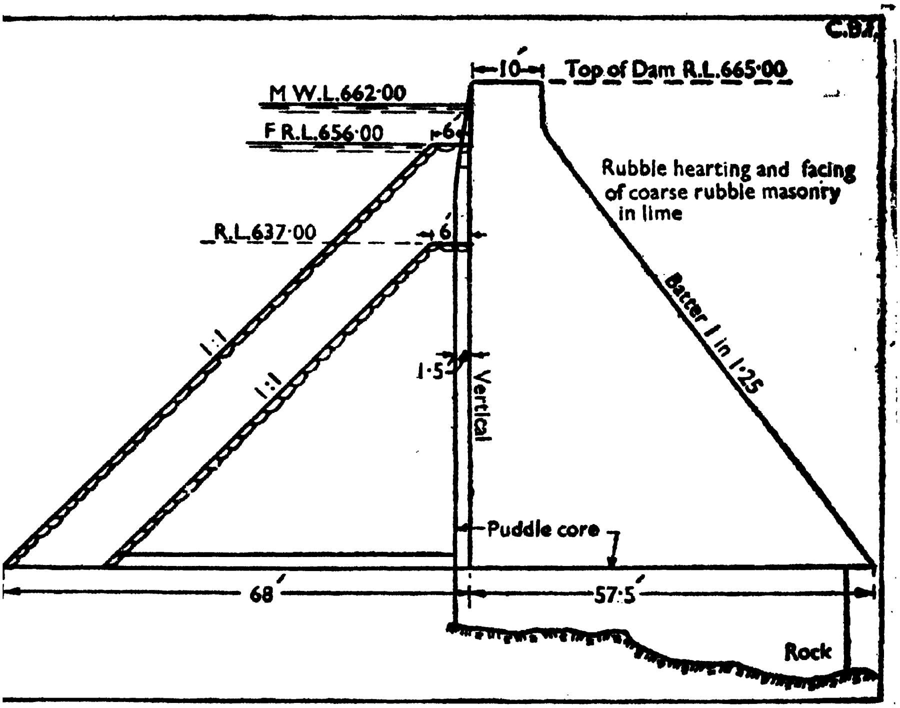
A. STATISTICAL

(1) Reservoir Data	
(*a*) M. W. L.	R. L. 662·00
(*b*) F. R. L.	R. L. 656·00
(*c*) Area at M. W. L.	6·2 square miles
(*d*) Area at F. R. L.	
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	
(*b*) Live	**134,550 acre feet**
(*c*) Flood storage	
(*d*) Carry-over	



Cross section of Pagara Dam (Earthen portion)

(3) Maximum height above the lowest point of foundations	Masonry portion — 77 feet Earthen portion — 97·4 feet
(4) Height above the lowest river bed at dam	Masonry portion — 74 feet Earthen portion — 89·4 feet
(5) Height of the top of the dam above the crest of the spillway or weir	Masonry portion — 9 feet Earthen portion — 16 feet
(6) Maximum width at level of foundation	Masonry portion — 57·5' feet—excluding upstream earthen Earthen portion — 470 feet as per sketch
(7) Width at top	Masonry portion — 10 feet Earthen portion — 20 feet



Cross Section of Pagara Dam, Masonry portion

(8) Slopes

(a) Upstream
(b) Donwstream } As per cross section

(9) Length at top of the dam	**Masonry portion — 1,180 feet** **Earthen portion — 4,720 feet** **Total 5,900 feet**
(*a*) Non-overflow	
(*i*) Main	5,660 feet
(*b*) Spillway	240 feet
(10) Cubic volume of the body of the dam	Earthen portion — 17,720,000 cubic feet Masonry portion —1,600,000 cubic feet Total 19,320,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Masonry portion—Rubble hearting in lime between faces of coursed rubble and masonry in lime Earthen portion, selected earth in hearting and *kopra* and other porous materials in casing
(12) Specific gravity	
(*a*) Masonry	2·24 lbs.
(*b*) Earthfill	
(13) Nature of protection and water-proofing of the upstream and down-stream faces	Masonry portion — Cement pointing Earthen portion — Reinfnorced concrete slabs on upstream side
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundation of the dam	Masonry portion — Cement pointing Earthen portion—Masonry core-wall in the centre and 9 inches thick reinforced concrete slab is provided on upstream side from ground level to F. R. L. An additional trench to an average depth of 33 feet below ground level from R. D. 200 to R. D. 4,600 filled up with cement concrete is provided at the upstream of the dam as per sketch.
16) Contraction joints	
(17) Principal stresses in the masonry with a note of methods of calculations employed	

(18) Maximum pressure on foundations	
(19) Uplift pressure, calculated or measured	
(20) Measures adopted for preventing or counteracting uplift pressures·	
(21) Hydraulic gradient for which the embankment is designed	
(22) Particulars of the berm (if any) width and position	
(23) Position and form of the core wall (or other means of securing water tightness)	As per cross section
(24) Batter (if any) of the core-wall	As per cross section
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	
(26) Method of keying core-wall or other wall in the underlying ground	By means of trenching
(27) Nature of material forming the core or other wall	Masonry

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*

- (*a*) Crown waste
- (*b*) Proprietory

(2) *Dislocation*

- (*a*) Villages
- (*b*) Families
- (*c*) Population
- (*d*) Roads
  - (*i*) Highways
  - (*ii*) District roads
  - (*iii*) Village roads
- (*e*) Railway lines
- (*f*) Temples, mosques, etc.
- (*g*) Graves, etc.
- (*h*) Trees, gardens, pastures, houses, wells, etc.
- (*i*) **Bridges**

(3) Compensation paid under each category of item (2)	
(4) Method of compensating for land of dispossessed landholders	

V. AUXILIARY WORKS

(1) Surplussing works	There are six automatic gates each 40 feet span and six feet in height
(2) Outlet works (3) Scouring works	Sluice gate with two openings 6 feet by 3 feet in the masonry dam
(4) Inspection facilities	Tunnel is accessible for inspection from out side.
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII—SUPPLEMENTARY INFORMATION

(1) Constructional features	
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	The earthen dam after completion began to show signs of leakage which grew enormously as time passed. The quality of earth of which the bund was composed was mainly responsible for it. C. C. slabs on the Upstream side slopes of the dam resting on a cement concrete for wall carried sufficiently deep in the soil to prevent seepage were provided. This has reduced the leakage.
(3) Noteworthy occurrences and accidents	Breached in 1943 owing to heavy rains Masonry portion washed off.
(4) Operation of the dam	
(*a*) Regulation	
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	

(*d*) Various measurements and observations	
(*i*) Evaporation losses.	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	It is economical to build earthen dam with masonry than an earthen dam with unsuitable materials. Reservoir is used for Irrigation purposes. The rainfall records of the previous years have upset all the established rules.

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	The investigations were carried on by Messrs Cullabawala and Shevendas. It was constructed by Mr. E. L. Glass, Assistant Engineer of the Punjab Irrigation Department. Col. Pitcher, Chief Engineer.
(2) Personnel	Mr. E. L. Glass, Assistant Engineer.
(3) Bibliography	

X. 21. Chandia-Nala Dam

(Masonry Dam)

I. GENERAL

(1) Height above the lowest river bed	83 feet
(2) Location	Sagar district, Madhya Pradesh (Chandia Nala)
(3) Authority or owner	Madhya Pradesh Government
(4) Purpose-Main and subsidiary	Irrigation
(5) Year of commencement	1921
(6) Year of completion	1927
(7) Capital cost	
(a) Estimated	Rs. 4,18,712 (works only)
(b) Actual	Rs. 6,32,447 including all charges such as direct & indirect Rs. 3,90,341 for works only
(8) Culturable area commanded by the project	3,446 acres
(9) Area irrigated	568 acres of *kharif*, 934 acres of ***rabi*** and 89 acres of other crops
(11) Means of access	It is accessible by road from Sagar Railway station and at 43 miles from Sagar on Sagar Kanpur Road.

II. GEOPHYSICAL

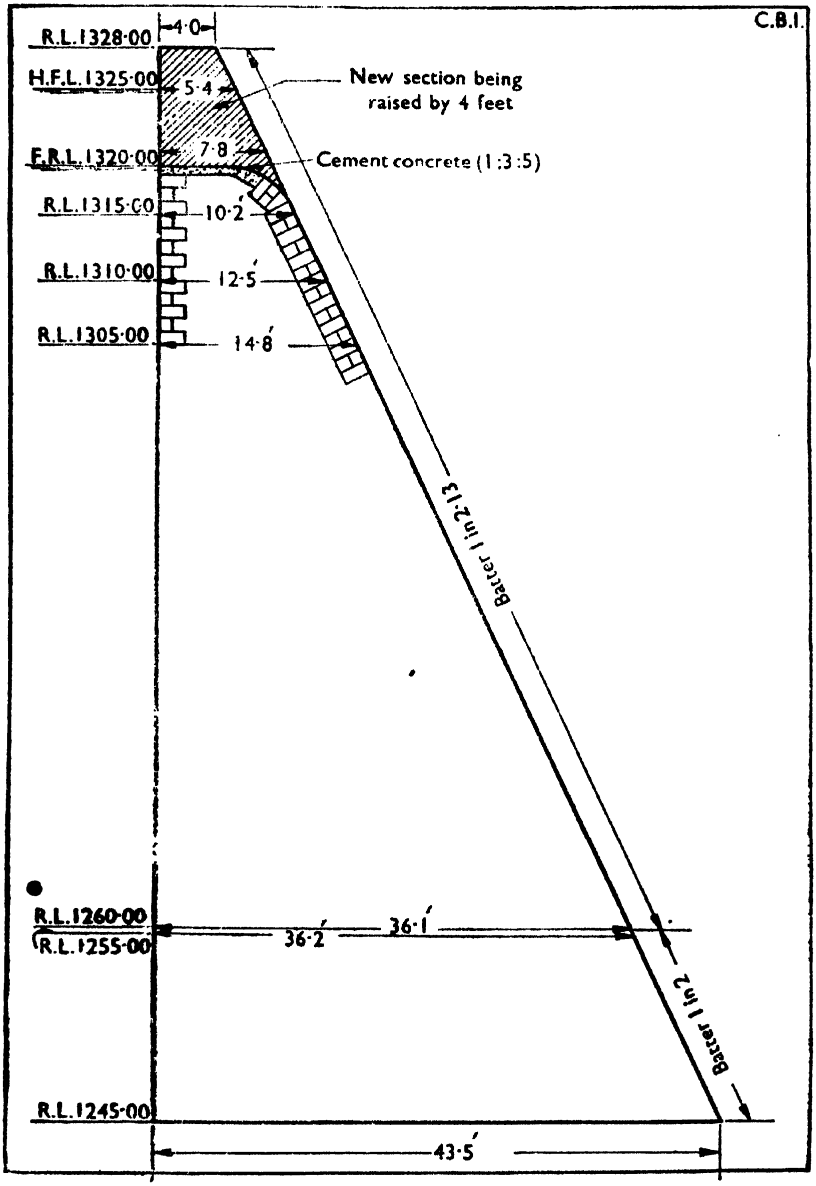
(1) Area of catchment	31 squre miles
(2) Nature of catchment	Thickly wooded, steep and hilly
(3) Mean annual precipitation	
(a) Rainfall	37·13 inches
(4) Total average annual yield of the catchment	48,493 acre feet
(5) Climate	Temperate
(6) Temperature conditions and variations	Maximum temperature 116° F in shade and variation of 20° F (mean)

(7) Rate of flow	
(*a*) Maximum	
(*b*) Minimum	
(8) Detritus charge of the stream	Clear for 8 months and silt laden for four months
(9) Character (chemical) of the water stored in the reservoir	
(10) Geological features	
(*a*) of foundations	The area has not been geologically surveyed but the rock near the site consists of Bijawar sand stone and conglomerates which is met with from ground level average depth of foundation below ground level being 5·7 feet.
(*b*) of catchment area	It is steep, rocky & rarley thickly wooded.

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M.W.L.	R.L. 1325·00
(*b*) F.R.L.	R.L. 1319·00
(*c*) Area at M.W.L.	0·44 square mile
(*d*) Area at F.R.L.	0·36 square miles
(*e*) Maximum length	1·25 miles
(*f*) Maximum width	0·75 miles
(*g*) Length of periphery	5·5 miles
(2) Capaicty of the reservoir	
(a) Gross	4,751 acre feet
(*b*) Live	4,675 acre feet
(*c*) Flood storage	1,551 acre feet
(*d*) Carry-over	1,558 acre feet
(3) Maximum height above the lowest point of foundations	83 feet
(4) Height above the lowest river bed at dam	83 feet
(5) Height of the top of the dam above the crest of the spillway or weir	9 feet
(6) Maximum width at level of foundation	43·5 feet
(7) Width at top	4·0 feet and 6·0 feet (for masonry and earthen portions respectively)



Cross section of Chandia-Nala Dam

(8) Slopes	
(*a*) Upstream	Vertical
(*b*) Downstream	2 to 1 up to R.L. 1259·6 and 100/47 above this level
(9) Length at top of the dam	1,081 feet i.e. 983 feet masonry dam and 98 feet earthen dam
(*a*) Non-overflow	
(*i*) Main	431 feet.
(*ii*) Subsidiary	98 feet
(*b*) Spillway	Main waste weir =327 feet, two emergency waste weirs 133·7 feet and 111·3 feet.
(10) Cubic volume of the body of the dam.	690,000 cubic feet of masonry and 5,000 cubic feet of earthem dam

B. OTHERS

(11) Material of which the dam is constructed	The faces have been constructed of rubble masonry with hearting of plum lime concrete. Faces pointed with cement mortar.
(12) Specific gravity	
(*a*) Masonry	2·24
(13) Nature of protection and waterproofing of the upstream and downstream faces	Cement pointing
(14) Provision for dealing with seepage and drainage water	No provision exists. It is a masonry dam.
(15) Means of securing water tightness of the foundation of the dam	Cement pointing and cement concreting
(16) Contraction joints	Not provided being masonry dam
(17) Principal stresses in the masonry with a note of methods of calculations employed	The calculations were made assuming that water level would be at highest flood level, and the maximum intensity of pressure would be 12 tons per square foot and that the weight of the material, used in the dam was 140 lb. per cubic foot.
(18) Maximum pressure on foundations	7·5 tons per square foot at the outer edge
(19) Uplift pressure, calculated or measured	
(20) Measures adopted for preventing or counteracting uplift pressures	

(21) Hydraulic gradient for which the embankment is designed	It is masonry dam and hence no consideration for Hydraulic gradient has been allowed.
(22) Particulars of the berm (if any) width and position	
(23) Position and form of the core wall (or other means of securing water tightness)	Hearting of plum lime concrete after allowing 2 feet width for skin stone masonry from both the faces and 3 feet below the top of the dam.
(24) Batter (if any) of the corewall	47 in 100 from R.L. 1259·6 to R.L. 1325·0 and 1 : 2 from R.L. 1245 to R.L.1259·6
(25) Maximum depth below ground surface of core wall or other means of securing water tightness	The depth of core below ground level varies generally from 2 feet to 6 feet.
(26) Method of keying core-wall or other wall in the underlying ground	The foundations were roughened with chisels and all fissures were grouted with cement. Where the rock had warm smooth, holes were bored in the rock to a depth of 6" and pick-axes were embedded in cement mortar to form the joints with superstructure.
(27) Nature of material forming the core or other wall	The hearting consists of plum lime concrete with 1½ inches gauge metal laid in 3 inches layer with 25 per cent plums, size of plum being not less than one cft.

V. AUXILIARY WORKS

(1) Surplussing works	Length of main waste weir is 327 feet. There are two more emergency waste weirs of 133·7 feet and 111·3 feet length. The discharging capacity of the weirs is 17,885 cusecs
(2) Outlet works	Sluice gate of penstock pattern 2 feet by 2 feet
(3) Scouring works	Not necessary. The bed being of solid rock
(4) Inspection facilities	The site is at a distance of about 2½ miles from P.W.D. Rest House at Shahgarh and approach is motorable.
(5) Fish pass	

(6) Means for dissipating energy below the spillway	The *nala* bed on which the water from the waste weir falls is of solid rock which is strengthened by cement grouting the fissures and filling cement concrete in depressions. Further below the bed is rocky and firm.

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	The main features of the scheme are: – (1) A masonry dam, semi circular in plan with masonry flanks and small earthen bund across the saddle beyond the left flank of the dam. (2) A sluice built in right flank of the dam with a curved tunnel extending 58 feet beyond the downstream face. In continuation of the tunnel is an aqueduct of 3 spans each of 15 feet. (3) A distributary about 10 miles in length with a discharge head of 27·2 cusecs. On this distributary are 15 culverts, one aqueduct, 18 falls, 13 roads and one foot bridge. (4) Two minors to command Amormow Village. The original design was changed to raise the height of the dam by 4 feet and the lower dam omitted as ordered by the Chief Engineer.
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurrences and accidents	There are a number of small leak holes in the dam but they are not such as to endanger its safety or affect the supply. With a view to prevent this leakage the upstream face of the dam was repointed in the year 1926. Since then, experiments have been made with coloured water delivered in pipes at various points on the dam to locate the larger leaks and it was found that leakage occurred at about R.L. 1258 at R.D. 177 and between R.D.s 258 and 277.

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurrences and accidents	
(4) Operation of the dam	
(*a*) Regulation	Regulation is done through two sluice openings provided in the bund.
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta.	
(*c*) Actual yield as against estimated.	
(*d*) Various measurements and observations.	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilsation of the dam	

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	Originally the scheme was proposed and recommended by Mr. F. F. Bios, the then Executive Engineer in 1913. Later on Mr. M. A. Higgs, the then Executive Engineer, took the scheme in hand. He started with the preliminary investigations of the scheme etc. and in

	1924 after completing the investigations he submitted an estimate to the Government which was sanctioned. So the scheme was completed in 1929 at the total cost of Rs. 6,25,840.
(2) Personnel	1. Mr. Nanak Singh, Executive Engineer 2. Mr. J. P. Seoni, Assistant Engineer
(3) Bibliography	

X. 24. Rampur Dam

(Earthen and masonry)

Composite

I. GENERAL

(1) Height above the lowest river bed	Masonry portion 56 feet Earthen portion 71 feet
(2) Location	Guna District, Madhya Bharat Union, (Nagri *Nala*)
(3) Authority or owner	Mahdya Bharat Union
(4) Purpose Main and subsidiary	Irrigation
(5) Year of commencement	1908
(6) Year of completion	1931
(7) Capital cost	
(*a*) Estimated	Rs. 7,17,861
(*b*) Actual	Rs. 5,16,641
(8) Culturable area commanded by the project	
(9) Area irrigated	
(11) Means of access	

II. GEOPHYSICAL

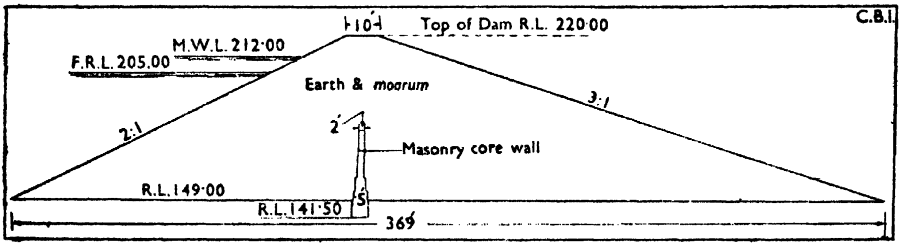
(1) Area of catchment	102 square miles
(2) Nature of catchment	
(3) Mean annual precipitation	
(*a*) Rainfall	38·2 inches
(4) Total average annual yield of the catchment	5,285 acre feet
(5) Climate	Tropical
(6) Temperature conditions and variations	Intense heat in summer and nearly freezing in winter

(7) Rate of Flow	
(*a*) Maximum	20,261 cusecs
(*b*) Minimum	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	Turbid with finely divided suspended matter
(10) Geological features	
(a) of foundations	Dam founded on hard rock
(*b*) of catchment area	The catchment basin is of undulating character and badly cut up by cross drainages and ravines.
(11) Earthquake (zone and intensities)	

III. TECHNICAL

A. STATISTICAL

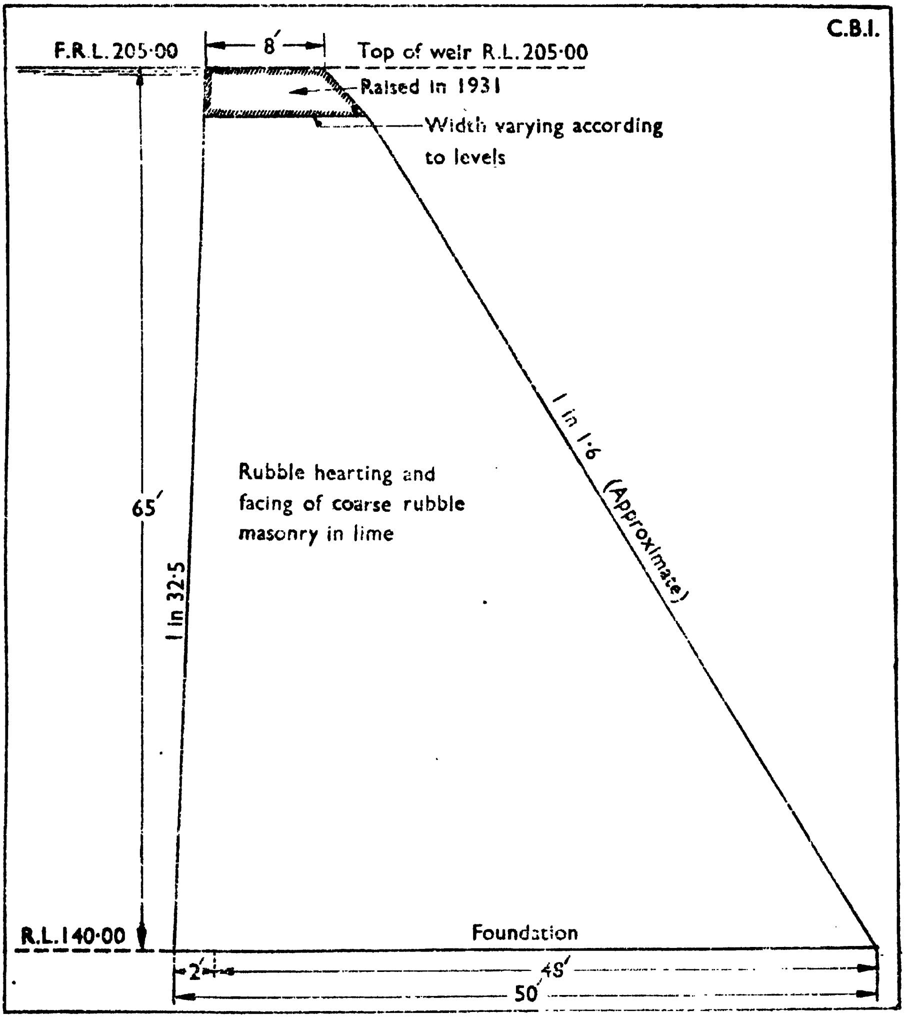
(1) Reservoir Data	
(*a*) M. W. L.	R. L. 212·00 } from an arbitrary datum
(*b*) F. R. L.	R. L. 205·00 } from an arbitrary datum
(*c*) Area at M. W. L.	3·04 square miles
(*d*) Area at F. R. L.	
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	
(*b*) Live	27,513 acre feet
(*c*) Flood storage	
(*d*) Carry-over	



Cross section of Rampur Dam Earthen portion

3) Maximum height above the lowest point of foundations	Masonry portion 65 feet Earthen portion 78·5 feet
(4) Height above the lowest river bed at dam	Masonry portion 56 feet Earthen portion 71 feet

(5) Height of the top of the dam above the crest of the spillway or weir	Masonry portion itself is an overfall weir Earthen portion, 15 feet
(6) Maximum width at level of foundation	Masonry portion 50 feet Earthen portion 369 feet
(7) Width at top	Masonry portion 8 feet Earthen portion 10 feet



Cross section of Rampur Dam Masonry portion

(8) Slopes	
(*a*) Upstream (*b*) Downstream	As per cross section
(9) Length at top of the dam	Masonry portion 450 feet Earthen portion 4,800feet } 5,250 feet
(*a*) Non-overflow	
(*i*) Main	4,350 feet
(*b*) Spillway	450 feet at R. L. 207·00 subsidiary weir 450 feet at R. L. 205·00 waste weir Total 900 feet
(10) Cubic volume of the body of the dam	Masonry portion 1,221,000 cubic feet Earthen portion 11,770,000 cubic feet. Total 12,991,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed.	Masonry portion—Rubble hearting in lime between faces of corused rubble masonry in lime Earthen portion -Earth and moorum
(12) Specific gravity	
(*a*) Masonry	2.24
(*d*) Earthfill	
(13) Nature of protection and waterproofing of the upstream and downstream faces	Masonry portion—Pointing on the upstream face of the dam Earthen portion—Dry stone pitching on upstream face
(14) Provision for dealing with seepage and drainage water.	
(15) Means of securing water tightness of the foundation of the dam	Masonry portion—Pointing on the upstream face of the dam Earthen portion—By means of core-wall
(16) Contraction joints	
(17) Principal stresses in the masonry with a note on methods of calculations employed	
(18) Maximum pressure on foundations	

(19) Uplift pressure, calculated or measured	
(20) Measures adopted for preventing or counteracting uplift pressures	
(21) Hydraulic gradient for which the embankment is designed	
(22) Particulars of the berm (if any) width and position	
(23) Position and form of the core-wall (or other means of securing water tightness)	As per cross section
(24) Batter (if any) of the core-wall	Masonry core-wall 2 feet at top and 5 feet at bottom and constructed with steps
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	7·5 feet
(26) Method of keying core-wall or other wall in the underlying ground	Masonry core-wall
(27) Nature of material forming the core-wall or other wall	Masonry

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory

(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads
    (*i*) Highways
    (*ii*) District roads
    (*iii*) Village roads
  (*e*) Railway lines
  (*f*) Temples, mosques, etc.
  (*g*) Graves, etc.
  (*h*) Trees, gardens, Pastures, Houses, wells, etc.
  (*i*) Bridges

(3) Compensation paid under each category of item (2)	
(4) Method of compensating for land of dispossessed landholders	

V. AUXILIARY WORKS

(1) Surplussing works	Subsidiary weir 450 feet long at R. L. 207·00, Waste weir 450 feet long at R. L. 205·00, Total length 900 feet and the discharging capacity is 40,000 cusecs.
(2) Outlet works	Two sluice gates, one on right bank cill at R. L. 176·00 and the other on left bank cill at R. L. 165·00.
(3) Scouring works	Scouring sluice at R. L. 148 in river bed in masonry portion
(4) Inspection facilities	Tunnel accessible for inspection from outside
(5) Fish pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying on the work.

(3) Noteworthy occurrences and accidents.

(4) Operation of the dam
  - (*a*) Regulation
  - (*b*) Silting of the reservoir
    - (*i*) Total silt deposited
    - (*ii*) Rate of silting
    - (*iii*) Density of the silt deposited
    - (*iv*) Rate of advancement of delta
  - (*c*) Actual yield as against estimated

(*d*) Various measurements and observations	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	The rainfall records for the last four years have upset all the established rules of calculations of runoffs *etc.* The subsidiary weir as a consequence thereto breached necessitating the closure of this gap completely with an earthen bund while diverting the surplus water along the main weir with increased flood lift. A water cushion has been provided in the downstream of main weir.

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	The scheme was initiated by Munshi Gajpatrai, the then district magistrate of Isagarh District. His idea was to irrigate the country lying between Puraini and Prabati rivers, harnessing the Nagri nala. Mr. Sydney Preston, Inspector General of Irrigation who joined the state, after his retirement from the British India, suggested the site for dam near Rampur. In 1908 the scheme as amended by Mr. Preston, was sanctioned, and Mr. H. K. Gurt sub-engineer was put on detailed investigation of the project.
(2) Personnel	
(3) Bibliography	

X. 25. Aunjhar Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	70·6 feet
(2) Location	Banda District, Uttar Pradesh
(3) Authority or owner	Uttar Pradesh Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1918
(6) Year of completion	1931
(7) Capital cost	
(*a*) Estimated	
(*b*) Actual	Rs. 3,01,364/-
(8) Culturable area commanded by the project	4,469 acres
(9) Area irrigated average 1940-49	688 acres
(11) Means of access	It is accessible from Dabhaura Railway Station, distant 6 miles, on Manikpur Allahabad Section (Great Indian Peninsular Railway). Babri inspection house is also located near the dam site, approached by canal service road

II. GEOPHYSICAL

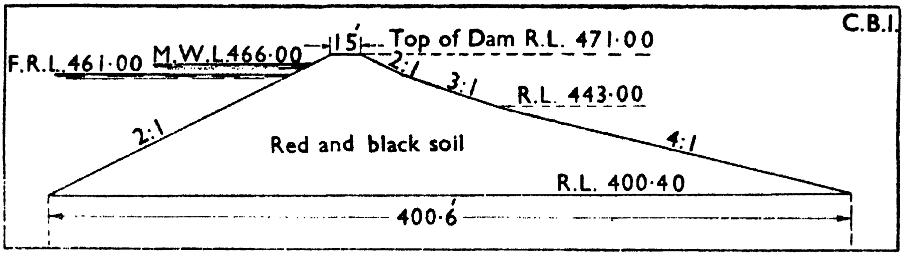
(1) Area of catchment	6·25 square miles
(2) Nature of catchment	Hilly
(3) Mean annual precipitation	
(*a*) Rainfall	36 inches
(4) Total average annual yield of the catchment	1,592·72 acre feet
(5) Climate	Dry
(6) Temperature conditions and variations	

7) Rate of Flow	
(*a*) Maximum	25·8 M. cft. per sq. mile of catchment
(*b*) Minimum	4·94 M. cft. per sq. mile of catchment
8) Detritus charge of the stream	Silting above dam is very smal
(9) Character (chemical) of the water stored in the reservoir	Clear except in rainy season
(10) Geological features	
(*a*) of foundations	Partly on light Bundel-khand soil, and partly on rock
(*b*) of catchment area	
(11) Earthquake (zone and intensities)	There are light tremors, but causing no damage

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M. W. L.	R. L. 466·00
(*b*) F. R. L.	R.L. 461·00
(*c*) Area at M. W. L.	
(*d*) Area at F. R. L.	0·3125 sq. miles
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	4,017·48 acre feet
(*b*) Live	3,712·12 acre feet
(*c*) Flood storage	
(*d*) Carry-over	267·45 acre feet



Cross section of Aunjhar Dam

(3) Maximum height above the lowest point of foundations	70·6 feet
(4) Height above the lowest river bed at dam	70·6 feet

(5) Height of the top of the dam above the crest of the spillway or weir	10 feet
(6) Maximum width at level of foundation	400·6 feet
(7) Width at top	15 feet
(8) Slopes	
(*a*) Upstream	2 : 1
(*b*) Donwstream	2 : 1, 3 : 1, and 4 : 1
(9) Length at top of the dam	3,464 feet
(*a*) Non overflow	
(*i*) Main	3,194 feet
(*b*) Spillway or Weir	270 feet
(10) Cubic volume of the body of the dam	12,898,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Light soil
(12) Specific gravity	
(13) Nature of protection and water proofing of the upstream and downstream faces	Upstream face is covered with one foot stone pitching, one foot above M. W. L. and stone pitching downstream in sections only
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundation of the dam	Rubble masonry core-wall in lime only at both ends of the dam
(22) Particulars of the berm (if any) width and position	
(23) Position and form of the core-wall (or other means of securing water tightness)	Rubble stone masonry core wall provided only at either ends of the dam
(24) Batter (if any) of the core-wall	1 in 32
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	5·5 feet
(26) Method of keying core-wall or other wall in the underlying ground	By trenching and founded on rock
(27) Nature of material forming the core or other wall	Rubble masonry in lime

IV. PARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory
(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads
    (*i*) Highways
    (*ii*) District roads
    (*iii*) Village roads
  (*e*) Railway lines
  (*f*) Temples, mosques, etc.
  (*g*) Graves, etc.
  (*h*) Trees gardens, pastures, houses, wells, etc.
  (*i*) Bridges
(3) Compensation paid under each category of item (2)
(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	The dam is provided with a weir 270 feet in length and designed to discharge 6,045 cusecs up to a water depth of 5 feet above crest at R. L. 461·00
(2) Outlet works	Two canal sluices, size of aperture 2 feet × 2 feet
(3) Scouring works	
(4) Inspection facilities	
(5) Fish pass	
(6) Means for dissipating energy below the spillway	There was some damage in 1939 when a baffle wall 1·25 feet in height at a distance of 150 feet downstream was constructed

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	By manual labour
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	

(3) Noteworthy occurrences and accidents

(4) Operation of the dam
  - (*a*) Regulation
  - (*b*) Silting of the reservoir
    - (*i*) Total silt deposited
    - (*ii*) Rate of silting
    - (*iii*) Density of the silt deposited
    - (*iv*) Rate of advancement of delta
  - (*c*) Actual yield as against estimated
  - (*d*) Various measurements and observations
    - (*i*) Evaporation losses
    - (*ii*) Sweating below the dam
    - (*iii*) Temperature measurements
    - (*iv*) Seepage and regeneration
  - (*e*) Fish culture
  - (*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	The scheme for Aunjhar tank was recommended by Mr. F. F. Bion, Executive Engineer in 1911. Later on Mr. H. Lane, Executive Engineer took the scheme in hand and got sanctioned from the Government in 1918. The scheme was completed in 1931 at a total cost of Rs. 3,01,364/-
(2) Personnel	(1) Mr. Moti Ram, Executive Engineer (2) Mr. U. L. Chaturvedi, Assistant Engineer
(3) Bibliography	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurrences and accidents	
(4) Operation of the dam	
(*a*) Regulation	Regulation is done through two sluice openings provided in the bund.
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta.	
(*c*) Actual yield as against estimated.	
(*d*) Various measurements and observations.	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilsation of the dam	

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	Originally the scheme was proposed and recommended by Mr. F. F. Bios, the then Executive Engineer in 1913. Later on Mr. M. A. Higgs, the then Executive Engineer, took the scheme in hand. He started with the preliminary investigations of the scheme etc. and in

1924 after completing the investigations he submitted an estimate to the Government which was sanctioned. So the scheme was completed in 1929 at the total cost of Rs. 6,25,840.

(2) Personnel

1. Mr. Nanak Singh, Executive Engineer
2. Mr. J. P. Seoni, Assistant Engineer

(3) Bibliography

X. 24. Rampur Dam

(Earthen and masonry)

Composite

I. GENERAL

(1) Height above the lowest river bed	Masonry portion 56 feet Earthen portion 71 feet
(2) Location	Guna District, Madhya Bharat Union, (Nagri *Nala*)
(3) Authority or owner	Mahdya Bharat Union
(4) Purpose Main and subsidiary	Irrigation
(5) Year of commencement	1908
(6) Year of completion	1931
(7) Capital cost	
(*a*) Estimated	Rs. 7,17,861
(*b*) Actual	Rs. 5,16,641
(8) Culturable area commanded by the project	
(9) Area irrigated	
(11) Means of access	

II. GEOPHYSICAL

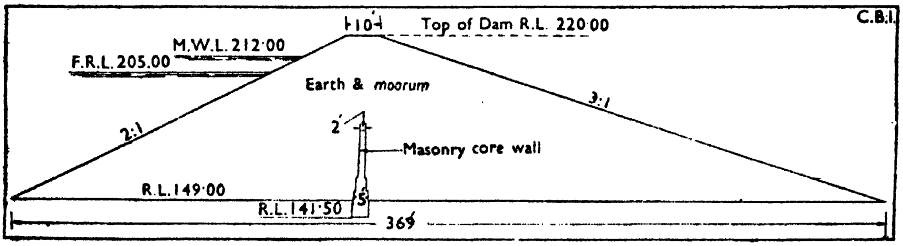
(1) Area of catchment	102 square miles
(2) Nature of catchment	
(3) Mean annual precipitation	
(*a*) Rainfall	38·2 inches
(4) Total average annual yield of the catchment	5,285 acre feet
(5) Climate	Tropical
(6) Temperature conditions and variations	Intense heat in summer and nearly freezing in winter

(7) Rate of Flow	
(*a*) Maximum	20,264 cusecs
(*b*) Minimum	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	Turbid with finely divided suspended matter
(10) Geological features	
(*a*) of foundations	Dam founded on hard rock
(*b*) of catchment area	The catchment basin is of undulating character and badly cut up by cross drainages and ravines.
(11) Earthquake (zone and intensities)	

III. TECHNICAL

A. STATISTICAL

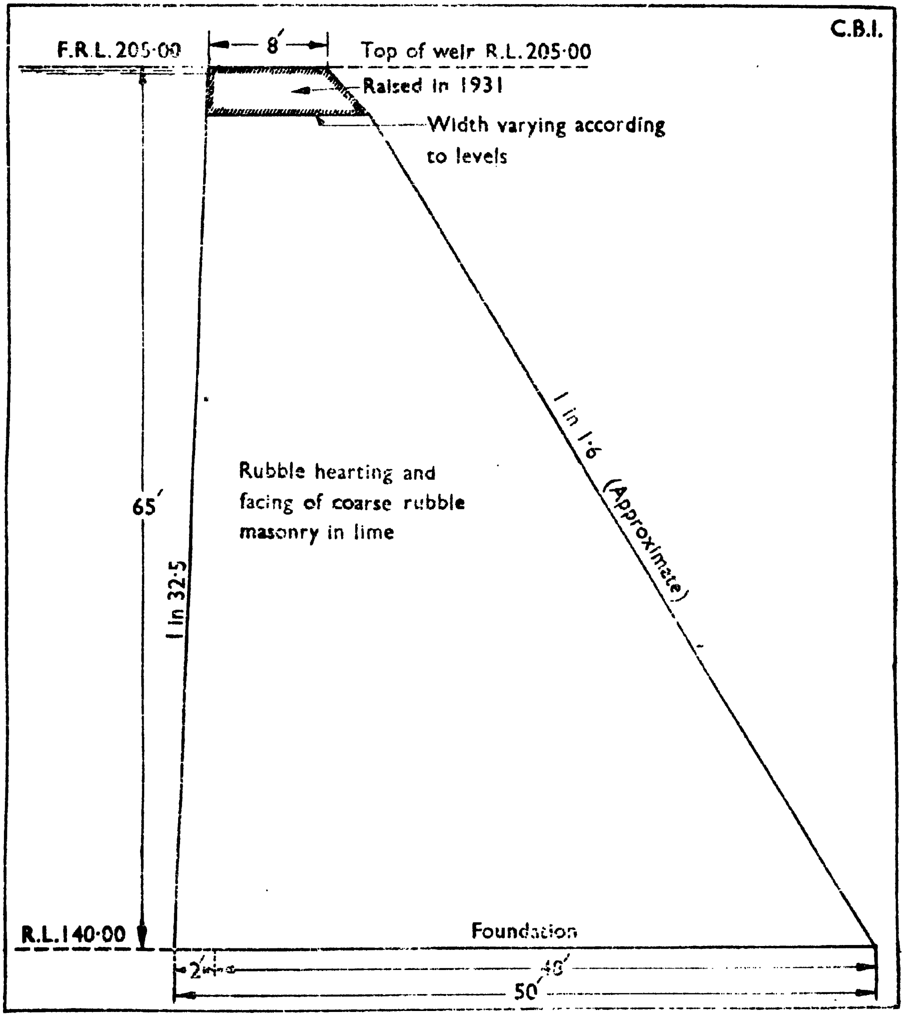
(1) Reservoir Data	
(*a*) M. W. L.	R. L. 212·00 } from an arbitrary datum
(*b*) F. R. L.	R. L. 205·00
(*c*) Area at M. W. L.	3·04 square miles
(*d*) Area at F. R. L.	
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	
(*b*) Live	27,513 acre feet
(*c*) Flood storage	
(*d*) Carry-over	



Cross section of Rampur Dam Earthen portion

(3) Maximum height above the lowest point of foundations	Masonry portion 65 feet Earthen portion 78·5 feet
(4) Height above the lowest river bed at dam	Masonry portion 56 feet Earthen portion 71 feet

(5) Height of the top of the dam above the crest of the spillway or weir	Masonry portion itself is an overfall weir Earthen portion, 15 feet
(6) Maximum width at level of foundation	Masonry portion 50 feet Earthen portion 369 feet
(7) Width at top	Masonry portion 8 feet Earthen portion 10 feet



Cross section of Rampur Dam Masonry portion

(8) Slopes	
(a) Upstream (b) Downstream	As per cross section
(9) Length at top of the dam	Masonry portion 450 feet Earthen portion 4,800feet 5,250 feet
(a) Non-overflow	
(i) Main	4,350 feet
(b) Spillway	450 feet at R. L. 207·00 subsidiary weir 450 feet at R. L. 205·00 waste weir Total 900 feet
(10) Cubic volume of the body of the dam	Masonry portion 1,221,000 cubic feet Earthen portion 11,770,000 cubic feet. Total 12,991,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed.	Masonry portion—Rubble hearting in lime between faces of coursed rubble masonry in lime Earthen portion—Earth and moorum
(12) Specific gravity	
(a) Masonry	2.24
(d) Earthfill	
(13) Nature of protection and waterproofing of the upstream and downstream faces	Masonry portion—Pointing on the upstream face of the dam Earthen portion—Dry stone pitching on upstream face
(14) Provision for dealing with seepage and drainage water.	
(15) Means of securing water tightness of the foundation of the dam	Masonry portion—Pointing on the upstream face of the dam Earthen portion—By means of core-wall
(16) Contraction joints	
(17) Principal stresses in the masonry with a note on methods of calculations employed	
(18) Maximum pressure on foundations	

(19) Uplift pressure, calculated or measured	
(20) Measures adopted for preventing or counteracting uplift pressures	
(21) Hydraulic gradient for which the embankment is designed	
(22) Particulars of the berm (if any) width and position	
(23) Position and form of the core-wall (or other means of securing water tightness)	As per cross section
(24) Batter (if any) of the core-wall	Masonry core-wall 2 feet at top and 5 feet at bottom and constructed with steps
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	7·5 feet
(26) Method of keying core-wall or other wall in the underlying ground	Masonry core-wall
(27) Nature of material forming the core-wall or other wall	Masonry

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
- (*a*) Crown waste
- (*b*) Proprietory

(2) *Dislocation*
- (*a*) Villages
- (*b*) Families
- (*c*) Population
- (*d*) Roads
  - (*i*) Highways
  - (*ii*) District roads
  - (*iii*) Village roads
- (*e*) Railway lines
- (*f*) Temples, mosques, etc.
- (*g*) Graves, etc.
- (*h*) Trees, gardens, Pastures, Houses, wells, etc.
- (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Subsidiary weir 450 feet long at R. L. 207·00, Waste weir 450 feet long at R. L. 205·00, Total length 900 feet and the discharging capacity is 40,000 cusecs.
(2) Outlet works	Two sluice gates, one on right bank cill at R. L. 176·00 and the other on left bank cill at R. L. 165·00.
(3) Scouring works	Scouring sluice at R. L. 148 in river bed in masonry portion
(4) Inspection facilities	Tunnel accessible for inspection from outside
(5) Fish pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features

(2) Changes introduced in the plans of the dam and in the method of carrying on the work.

(3) Noteworthy occurrences and accidents.

(4) Operation of the dam

- (*a*) Regulation
- (*b*) Silting of the reservoir
  - (*i*) Total silt deposited
  - (*ii*) Rate of silting
  - (*iii*) Density of the silt deposited
  - (*iv*) Rate of advancement of delta
- (*c*) Actual yield as against estimated

(*d*) Various measurements and observations	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	The rainfall records for the last four years have upset all the established rules of calculations of runoffs *etc.* The subsidiary weir as a consequence thereto breached necessitating the closure of this gap completely with an earthen bund while diverting the surplus water along the main weir with increased flood lift. A water cushion has been provided in the downstream of main weir.

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	The scheme was initiated by Munshi Gajpatrai, the then district magistrate of Isagarh District. His idea was to irrigate the country lying between Puraini and Prabati rivers, harnessing the Nagri nala. Mr. Sydney Preston, Inspector General of Irrigation who joined the state, after his retirement from the British India, suggested the site for dam near Rampur. In 1908 the scheme as amended by Mr. Preston, was sanctioned, and Mr. H. K. Gurt sub-engineer was put on detailed investigation of the project.
(2) Personnel	
(3) Bibliography	

X. 25. Aunjhar Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	70·6 feet
(2) Location	Banda District, Uttar Pradesh
(3) Authority or owner	Uttar Pradesh Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1918
(6) Year of completion	1931
(7) Capital cost	
(*a*) Estimated	
(*b*) Actual	Rs. 3,01,364/-
(8) Culturable area commanded by the project	4,469 acres
(9) Area irrigated average 1940-49	688 acres
(11) Means of access	It is accessible from Dabhaura Railway Station, distant 6 miles, on Manikpur Allahabad Section (Great Indian Peninsular Railway). Babri inspection house is also located near the dam site, approached by canal service road

II. GEOPHYSICAL

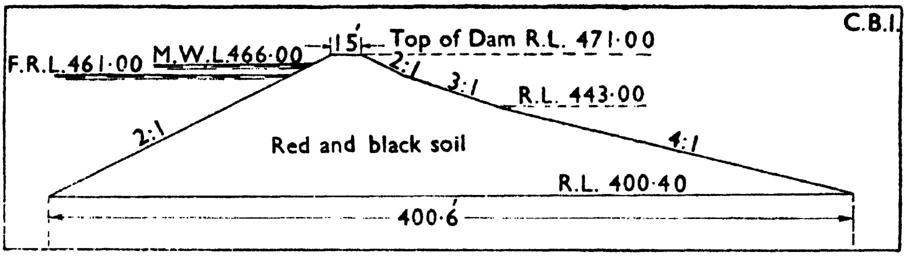
(1) Area of catchment	6·25 square miles
(2) Nature of catchment	Hilly
(3) Mean annual precipitation	
(*a*) Rainfall	36 inches
(4) Total average annual yield of the catchment	1,592·72 acre feet
(5) Climate	Dry
(6) Temperature conditions and variations	

7) Rate of Flow	
(*a*) Maximum	25·8 M. cft. per sq. mile of catchment
(*b*) Minimum	4·94 M. cft. per sq. mile of catchment
8) Detritus charge of the stream	Silting above dam is very smal
(9) Character (chemical) of the water stored in the reservoir	Clear except in rainy season
(10) Geological features	
(*a*) of foundations	Partly on light Bundel-khand soil, and partly on rock
(*b*) of catchment area	
(11) Earthquake (zone and intensities)	There are light tremors, but causing no damage

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M. W. L.	R. L. 466·00
(*b*) F. R. L.	R.L. 461·00
(*c*) Area at M. W. L.	
(*d*) Area at F. R. L.	0·3125 sq. miles
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	4,017·48 acre feet
(*b*) Live	3,712·12 acre feet
(*c*) Flood storage	
(*d*) Carry-over	267·45 acre feet



Cross section of Aunjhar Dam

(3) Maximum height above the lowest point of foundations	70·6 feet
(4) Height above the lowest river bed at dam	70·6 feet

(5) Height of the top of the dam above the crest of the spillway or weir	10 feet
(6) Maximum width at level of foundation	400·6 feet
(7) Width at top	15 feet
(8) Slopes	
(*a*) Upstream	2 : 1
(*b*) Donwstream	2 : 1, 3 : 1, and 4 : 1
(9) Length at top of the dam	3,464 feet
(*a*) Non overflow	
(*i*) Main	3,194 feet
(*b*) Spillway or Weir	270 feet
(10) Cubic volume of the body of the dam	12,898,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Light soil
(12) Specific gravity	
(13) Nature of protection and water proofing of the upstream and downstream faces	Upstream face is covered with one foot stone pitching, one foot above M. W. L. and stone pitching downstream in sections only
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundation of the dam	Rubble masonry core-wall in lime only at both ends of the dam
(22) Particulars of the berm (if any) width and position	
(23) Position and form of the core-wall (or other means of securing water tightness)	Rubble stone masonry core wall provided only at either ends of the dam
(24) Batter (if any) of the core-wall	1 in 32
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	5·5 feet
(26) Method of keying core-wall or other wall in the underlying ground	By trenching and founded on rock
(27) Nature of material forming the core or other wall	Rubble masonry in lime

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory
(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads
    (*i*) Highways
    (*ii*) District roads
    (*iii*) Village roads
  (*e*) Railway lines
  (*f*) Temples, mosques, etc.
  (*g*) Graves, etc.
  (*h*) Trees gardens, pastures, houses, wells, etc.
    (*i*) Bridges
(3) Compensation paid under each category of item (2)
(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	The dam is provided with a weir 270 feet in length and designed to discharge 6,045 cusecs up to a water depth of 5 feet above crest at R. L. 461·00
(2) Outlet works	Two canal sluices, size of aperture 2 feet × 2 feet
(3) Scouring works	
(4) Inspection facilities	
(5) Fish pass	
(6) Means for dissipating energy below the spillway	There was some damage in 1939 when a baffle wall 1·25 feet in height at a distance of 150 feet downstream was constructed

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	By manual labour
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	

(3) Noteworthy occurrences and accidents

(4) Operation of the dam

- (*a*) Regulation
- (*b*) Silting of the reservoir
  - (*i*) Total silt deposited
  - (*ii*) Rate of silting
  - (*iii*) Density of the silt deposited
  - (*iv*) Rate of advancement of delta
- (*c*) Actual yield as against estimated
- (*d*) Various measurements and observations
  - (*i*) Evaporation losses
  - (*ii*) Sweating below the dam
  - (*iii*) Temperature measurements
  - (*iv*) Seepage and regeneration
- (*e*) Fish culture
- (*f*) Anti-malaria measures

(5) Recreation facilities

(6) Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical

The scheme for Aunjhar tank was recommended by Mr. F. F. Bion, Executive Engineer in 1911. Later on Mr. H. Lane, Executive Engineer took the scheme in hand and got sanctioned from the Government in 1918. The scheme was completed in 1931 at a total cost of Rs. 3,01,364/-

(2) Personnel

(1) Mr. Moti Ram, Executive Engineer

(2) Mr. U. L. Chaturvedi, Assistant Engineer

(3) Bibliography

X. 26. Kaketo (Supplementary) Dam

(Masonry)

I. GENERAL

(1) Height above the lowest river bed	105·7 feet
(2) Location	Madhya Bharat Union (Parvati river)
(3) Authority or owner	Madhya Bharat Union
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1919
(6) Year of completion	1933
(7) Capital cost	
(*a*) Estimated	Rs. 41,61,000
(*b*) Actual	Rs. 35,10,773
(8) Culturable area commanded by the project	
(9) Area irrigated	
(11) Means of access	

II. GEOPHYSICAL

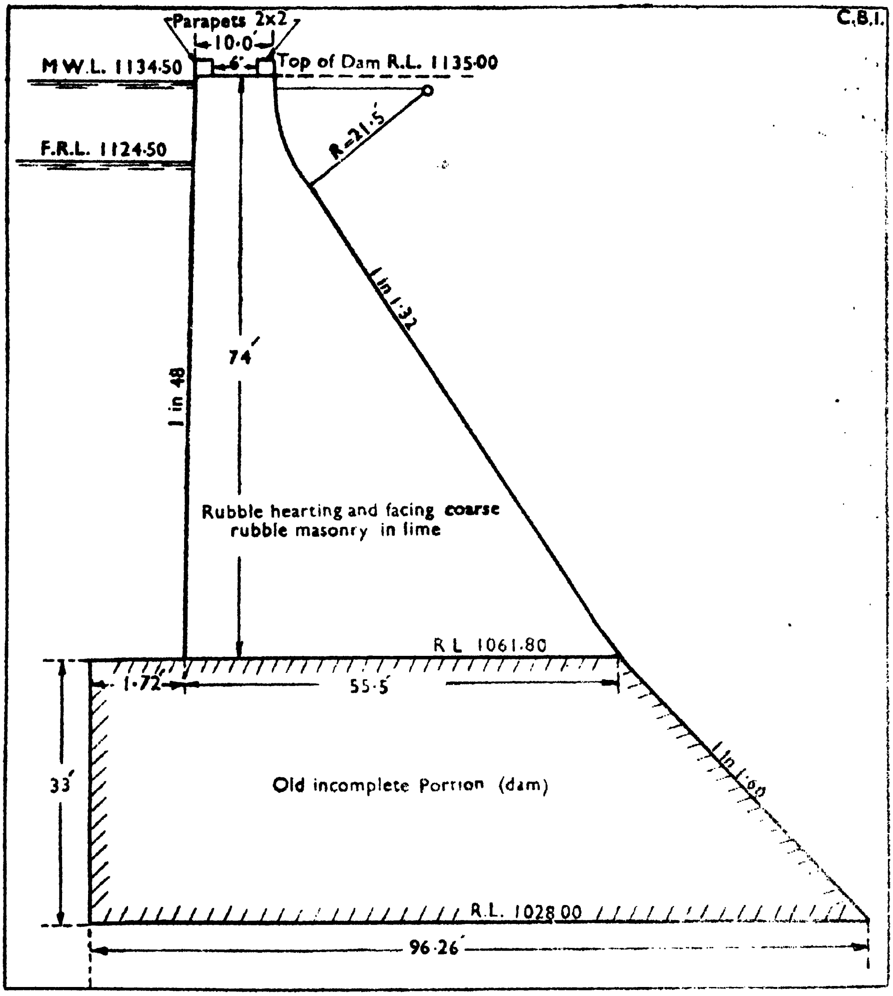
(1) Area of catchment	400 square miles
(2) Nature of catchment	Reservoir ground surface more or less rocky, and other area consists of barren rocky land and forest
(3) Mean annual precipitation	
(*a*) Rainfall	28 inches
(4) Total average annual yield of the catchment	1,49,610 acre feet
(5) Climate	Tropical
(6) Temperature conditions and variations	Intense heat in summer and freezing in winter occasionally
(7) Rate of flow	
(*a*) Maximum	
(*b*) Minimum	

(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	Muddy water having finely suspended matter
(10) Geological features	
(*a*) of foundations	Foundation on fissured aqucones rock
(*b*) of catchment area	

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(*a*) M. W. L.	R. L. 1134·50
(*b*) F. R. L.	R. L. 1124·50
(*c*) Area at M. W. L.	
(*d*) Area at F. R. L.	4·21 square miles
(*e*) Maximum length	
(*f*) Maximum width	
(*g*) Length of periphery	
(2) Capacity of the reservoir	
(*a*) Gross	
(*b*) Live	57,324 acre feet
(*c*) Flood storage	
(*d*) Carry-over	
(3) Maximum height above the lowest point of foundations	107·0 feet
(4) Height above the lowest river bed at dam	105·7 feet
(5) Height of the top of the dam above the crest of the spillway or weir	10·5 feet
(6) Maximum width at level of foundation	96·26 feet
(7) Width at top	10 feet
(8) Slopes	As per cross section
(*a*) Upstream	
(*b*) Downstream	
(9) Length at top of the dam	3,435 feet
(*a*) Non-overflow	
(*i*) Main	2,800 feet
(*b*) Spillway	635 feet
(10) Cubic volume of the body of the dam	6,000,000 cubic feet



Cross section of Kaketo Dam

B. OTHERS

(11) Material of which the dam is constructed	Rubble hearting in lime, between faces of coursed rubble masonry
(12) Specific gravity	
(*a*) Masonry	2·24
(13) Nature of protection and water-proofing of the upstream and down-stream faces	Pointing

(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundation of the dam	Pointing
(16) Contraction joints	
(17) Principal stresses in the masonry with a note of methods of calculations employed	
(18) Maximum pressure on foundations	5·8 tons per square foot
(19) Uplift pressure calculated or measured	
(20) Measures adopted for preventing or counteracting uplift pressures	Grouting with cement to a depth of 16 feet below the foundations

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
- (*a*) Crown waste
- (*b*) Proprietory

(2) *Dislocation*
- (*a*) Villages
- (*b*) Families
- (*c*) Population
- (*d*) Roads
    - (*i*) Highways
    - (*ii*) District roads
    - (*iii*) Village roads
- (*e*) Railway lines
- (*f*) Temples, mosques, etc.
- (*g*) Graves, etc.
- (*h*) Trees, gardens, pastures, houses, wells, etc.
- (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Waste weir, 635 feet long with a 10 foot flood lift, passes a discharge of 64,000 cusecs

(2) Outlet works	Two Stoney's sluice gates 8 feet by 8 feet with two ordinary gates One 19·5 feet below F. R. L. and the other one 74·5 feet below F.R.L.
(3) Scouring works	Scour valve 9 inches diameter
(4) Inspection facilities	
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	Rubble hearting in lime, between faces of coursed rubble masonry in lime and joints were cement pointed
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurrences and accidents	In 1943 the dam was subjected to heavy floods overtopping the dam ; but it stood all right
(4) Operation of the dam	
(a) Regulation	
(b) Silting of the reservoir	
(i) Total silt deposited	
(ii) Rate of silting	
(iii) Density of the silt deposited	
(iv) Rate of advancement of delta	
(c) Actual yield as against estimated	
(d) Various measurements and observations	
(i) Evaporation losses	
(ii) Sweating below the dam	
(iii) Temperature measurements	
(iv) Seepage and regeneration	
(e) Fish culture	
(f) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	The reservoir is behaving in accordance with expectations

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	In 1916, by the desire of His Highness the Late Maharaja, Mr. S. K. Gurtu, the then Chief Engineer of the state, prepared a preliminary Project for the Kaketo Reservoir together with a subsidiary dam and distribution system in the Parbati river valley for the dual purpose of irrigation and electric power supply to Gwalior Project was taken up for construction, but all works in connection with it were suspended in 1924. After proper reinvestigation and revision of the scheme by Rai Bahadur S. N. Bhaduri who completely discarded the electric supply scheme, and the work was restarted as a purely irrigation scheme in 1927. The amended scheme comprises the following (*i*) Kaketo reservoir, supplementing the Harsi Reservoir with no independent canal (*ii*) Harsi Reservoir with Masture canal
(2) Personnel	
(3) Bibliography	

X. 27. Aoda Dam

(Earthen and masonry)

(Composite)

I. GENERAL

(1) Height above the lowest river bed	Masonry portion 54·8 feet Earthen portion 50 feet
(2) Location	Sheopur district, Madhya Bharat Union (Sip river)
(3) Authority or owner	Madhya Bharat Union
(4) Purpose—Main and subsidiary	Irrigation and drinking purposes
(5) Year of commencement	Once abandoned and restarted in 1927
(6) Year of completion	1934
(7) Capital cost	
(a) Estimated	Rs. 27,68,800
(b) Actual	Rs. 23,64,173
(8) Culturable area commanded by the project	
(9) Area irrigated	
(11) Means of access	

II. GEOPHYSICAL

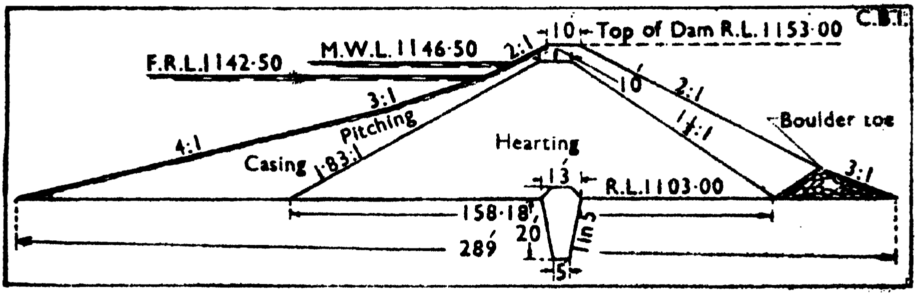
(1) Area of catchment	83 square miles
(2) Nature of catchment	
(3) Mean annual precipitation	
(a) Rainfall	28 inches
(b) Snow	
(4) Total average annual yield of the catchment	31,050 Acre feet
(5) Climate	Tropical
(6) Temperature conditions and variations	Intense heat in summer and near freezing in winter
(7) Rate of Flow	
(a) Maximum	
(b) Minimum	
(8) Detritus charge of the stream	

(9) Character (chemical) of the water stored in the reservoir	Turbid with fine suspended matter
(10) Geological features	
(a) of foundations	Masonry Portion Hard fissured igneous rock Earthen portion for a length of 3,000 feet from the left bank of the river the bottom of the puddle trench is in hard rock. For the remainder of its length 5,900 feet the puddle trench penetrates into yellow clayey soil
(b) of catchment area	
(11) Earthquake (zone and intensities)	Slight seismic disturbance in 1934 which produced some transverse cracks in the dam

III. TECHNICAL

A. STATISTICAL

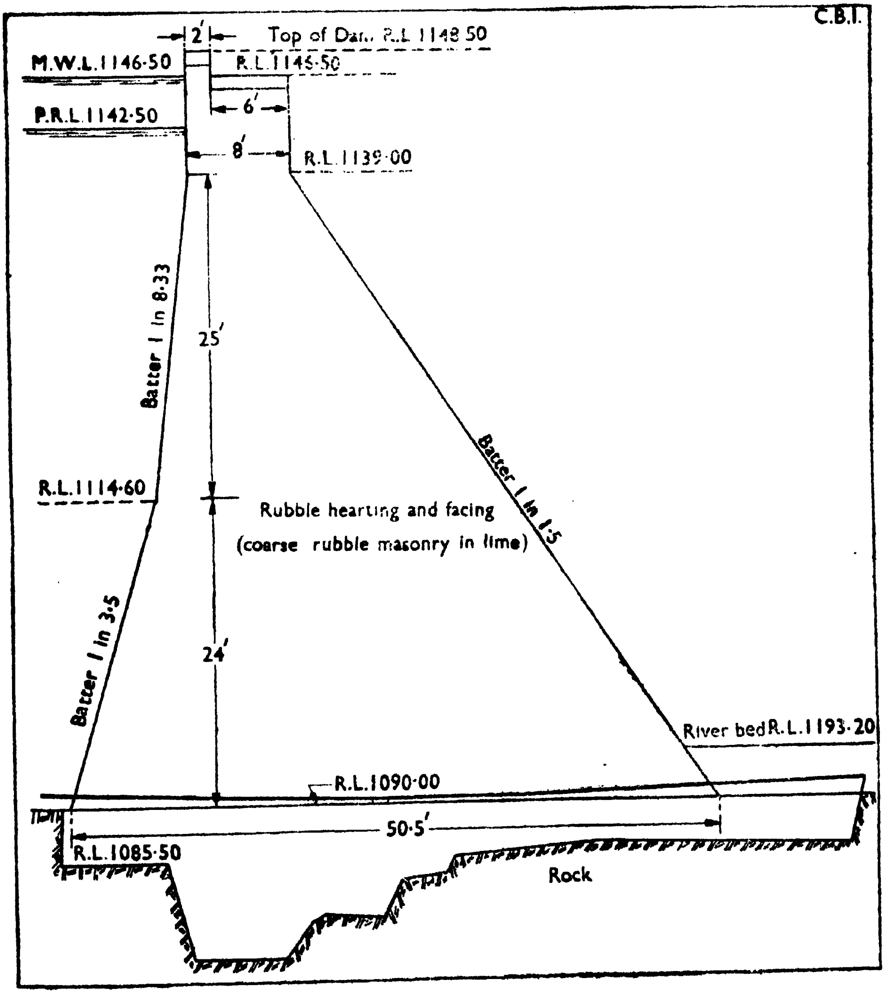
(1) Reservoir Data	
(a) M. W. L.	R. L. 1146·50
(b) F. R. L.	R. L. 1142·50
(c) Area at M. W. L.	
(d) Area at F. R. L.	3·59 square miles
(e) Maximum length	
(f) Maximum width	
(g) Length of periphery	
(2) Capacity of the reservoir	
(a) Gross	
(b) Live	35,658 acre feet
(c) Flood storage	
(d) Carry-over	



Cross section of Aoda Dam—Earthen portion

(3) Maximum height above the lowest point of foundations	Masonry portion 63 feet Earthen portion 70 feet

(4) Height above the lowest river bed at dam	Masonry portion 54.8 feet Earthen portion 50 feet
(5) Height of the top of the dam above the crest of the spillway or weir	Masonry portion 6 feet Earthen portion 10·5 feet
(6) Maximum width at level of foundation	Masonry portion 50·5 feet Earthen portion 289 feet
(7) Width at top	Masonry portion 8 feet Earthen portion 10 feet



Cross section of Aoda Dam—Masonry portion

(8) Slopes	
(*a*) Upstream (*b*) Downstream	As per cross section
(9) Length at top of the dam	Masonry portion, 5,100 feet Earthen portion 15,840 feet Total 20,940 feet
(*a*) Non-overflow	
(*i*) Main	19,440 feet
(*b*) Spillway	Waste weir 1,300 feet long on right flank and 200 feet on left flank Total length 1,500 feet
(10) Cubic volume of the body of the dam	Masonry portion 3,100,000 cubic feet Earthen portion 20,493,000 cubic feet Total 23,593,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Masonry portion—Rubble hearting in lime between faces of coursed rubble masonry Earthen portion—Selected earth for core wall and mixture of yellow soil and porous material for casing on both sides and stone pitching is provided on upstream side upto top level
(12) Specific gravity	
(*a*) Masonry	2·24
(*d*) Earthfill	
(13) Nature of protection and waterproofing of the upstream and downstream faces	Earthen portion—Upstream side is provided with dry stone pitching and loose hand-packed boulders provided on downstream side Masonry portion—Pointing
(14) Provision for dealing with seepage and drainage water	Pitching of boulders on downstream toe
(15) Means of securing water tightness of the foundation of the dam	Masonry portion—Between the upstream face wall consisting of a layer of masonry varying in thickness from 3 feet to 10 feet and the old face of the dam, a layer of cement concrete about 3 feet thick is provided. Earthen portion—A puddle core-wall
(16) Contraction joints	

(17) Principal stresses in the masonry with a note of methods of calculations employed	
(18) Maximum pressure on foundations	0·87 ton compression per square foot at toe, 2·5 tons compression per square foot at heel
(19) Uplift pressure, calculated or measured	It is taken equivalent to the depth of water in tail channel at the heel and half the height of upstream depth of water at the toe
(20) Measures adopted for preventing or counteracting uplift pressures	Grouting has been done to a depth of 8 feet below the bottom of the foundations
(21) Hydraulic gradient for which the embankment is designed	
(22) Particulars of the berm (if any) width and position	
(23) Position and form of the core-wall (or other means of securing water tightness)	As per cross section
(24) Batter (if any) of the core wall	1 in 5
(25) Maximum depth below ground surface of core-wall or other means for securing water tightness	20 feet
(26) Method of keying core-wall or other wall in the underlying ground	By puddle trenching
(27) Nature of material forming the core or other wall	Selected earth

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory
(2) *Dislocation*
  (*a*) **Villages**
  (*b*) **Families**
  (*c*) **Population**

(d) Roads
  (i) *Highways*
  (ii) District roads
  (iii) Village roads
(e) Railway lines
(f) Temples, mosques, etc.
(g) Graves, etc.
(h) Trees, gardens, pastures, houses, wells, etc.
(i) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Waste weir 1,300 feet in length is constructed on right flank and 200 feet in length is constructed on left flank. The depth of flood water over the crest is 4 feet
(2) Outlet works	Two sluice gates each 4 feet by 4 feet
(3) Scouring works	One scouring sluice 2 feet × 2 feet is provided in masonry portion
(4) Inspection facilities	Tunnel is accessible from outside for necessary inspection when required
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	Rubble hearting in hydraulic lime was provided between the dressed stone faces about 2 feet thick on each side
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	The cracks, caused by the slight disturbance of earthquake in 1934, were protected by alamina and buttresses were also provided on downstream side after grouting the cracks under pressure with cement

(3) Noteworthy occurrences and accidents	
(4) Operation of the dam	
(*a*) Regulation	
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	Silt survey was done in June 1940 and the depth of silt deposited was observed to be 4 inches
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	The reservoir is yielding the anticipated results
(*d*) Various measurements and observations	Only the influx into the tank is measured each year
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti-malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	At the instance of His Highness the late Maharaja, Mr. S. K. Gurtu, the then Chief Engineer initiated this scheme for drinking and irrigation purposes of the arid locality of the Sheopur District In the year 1927 R. B. S. N. Maduri restarted the construction of the work after consultation with Sir M. Visvesvarayya
(2) Personnel	
(3) Bibliography	

X. 28. Harsi Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	96·2 feet
(2) Location	Madhya Bharat Union (Parvati river)
(3) Authority or owner	Madhya Bharat Union
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1919
(6) Year of completion	1937
(7) Capital cost	
(*a*) Estimated	Rs. 85,29,000
(*b*) Actual	Rs. 77,42,903
(8) Culturable area commanded by the project	
(9) Area irrigated	
(11) Means of access	

II. GEOPHYSICAL

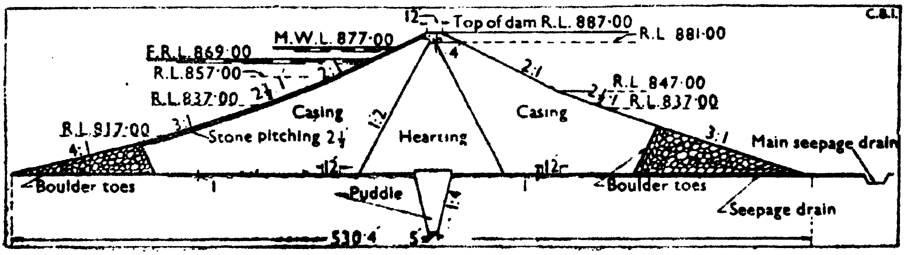
(1) Area of catchment	726 squares miles
(2) Nature of catchment	
(3) Mean annual precipitation	
(*a*) Rainfall	28 inches
(*b*) Snow	
(4) Total average annual yield of the catchment	2,96,884 acre feet
(5) Climate	Tropical
(6) Temperature conditions and variations	Intense heat in summer and nearly freezing in winter
(7) Rate of flow	
(*a*) Maximum	
(*b*) Minimum	

(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	Muddy water having finely divided suspended matter
(10) Geological features	
(a) of foundations	*River bed* Coarse sand and boulders overlying igneous rock, and in river banks, yellow loam under which white clayey earth and disintegrated rock are met with Reservoir—Water spread area is bounded by rocky hills covered with thin tree growth
(b) of catchment area	Catchment area—The first 400 square miles lie in rocky hills. The remainder is in cultivated land and with fairly steep slopes
(11) Earthquake (zone and intensities)	

III. TECHNICAL

A. STATISTICAL

(1) Reservoir Data	
(a) M. W. L.	R. L. 877·00
(b) F. R. L.	R. L. 869·00
(c) Area at M. W. L.	10·98 square miles
(d) Area at F. R. L.	
(e) Maximum length	
(f) Maximum width	
(g) Length of periphery	
(2) Capacity of the reservoir	
(a) Gross	
(b) Live	155,016 acre feet
(c) Flood storage	
(d) Carry-over	



Cross section of Harsi Dam

(3) Maximum height above the lowest point of foundations	104 feet
(4) Height above the lowest river bed at dam.	96·2 feet
(5) Height of the top of the dam above the crest of the spillway or weir	18 feett
(6) Maximum width at level of foundation	530·4 feet
(7) Width at top	12 feet
(8) Slopes	
(a) Upstream	As per cross section
(b) Downstream	
(9) Length at top of the dam	7,000 feet
(a) Non-overflow	
(i) Main	5,400 feet
(ii) Spillway	1,600 feet
(10) Cubic volume of the body of the dam	69,870,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Hearting of selected earth and casing of porous material. Upstream slope pitched with dry stones and has boulder toes
(12) Specific gravity	
(d) Earthfill	
(13) Nature of protection and waterproofing of the upstream and downstream faces	Upstream side pitched with dry stone and downstream side covered with *moorum*
(14) Provision for dealing with seepage and drainage water	Main and cross drains for seepage have been provided downstream of the dam
(15) Means of securing water tightness of the foundation of the dam	Puddle core-wall
(21) Hydraulic gradient for which the embankment is designed	
(22) Particulars of the berm (if any) width and position	
(23) Position and form of the core-wall (or other means of securing water tightness)	As per cross section

(24) Batter (if any) of the core-wall	1 in 4
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	46 feet
(26) Method of keying core-wall or other wall in the underlying ground	Key puddle trenching
(27) Nature of material forming the core or other wall	Clay puddle in trenches and selected earth hearting above ground

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory

(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads
    (*i*) Highways
    (*ii*) District roads
    (*iii*) Village roads
  (*e*) Railway lines
  (*f*) Temples, mosques, etc.
  (*g*) Graves, etc.
  (*h*) Trees, gardens, pastures, houses, wells, etc.
  (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplussing works	Waste weir consists of a masonry wall 10 feet high with 7 feet width at top and 11 feet at bottom. The waste weir is 1,600 feet in length along the curve and 1,440 feet on the chord. Waste weir is designed to discharge 168,000 cusecs

(2) Outlet works

(3) Scouring works	Three number Stoney sluice gates 8 feet by 8 feet in size, with three ordinary face gates on upstream
(4) Inspection facilities	
(5) Fish-pass	
(6) Means for dissipating energy below the spillway	Two falls 13 feet each have been provided 700 feet downstream of the weir

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	Hearting is done of selected earth and casing of porous material. Upstream slope pitched with hammer dressed dry-stone, and boulder toes have been provided in both up and downstream sides
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	The puddle trench was extended to nearly 100 feet more. Dewatering the trenches became a very serious problem specially by reason of copious discharge and slips in the sides. The sides were protected by *ballies* and bamboo *jalis*, and along that very powerful pumps were used in dewatering, and the pumped water was collected in a pit in the trench so that puddling could be done without any break
(3) Noteworthy occurrences and accidents	Masonry portion of waste weir washed off in the year 1943. The waste weir consists of a main weir with 10 feet fall and two separate falls with falls of 13 feet each at the downstream side of it. On account of heavy floods, the discharge of 132,000 cusecs passed through the weir. This damaged the 2nd 13 feet fall apron and undermined the founds of the downstream wing walls

(4) Operation of the dam
  (*a*) Regulation
  (*b*) Silting of the reservoir
    (*i*) Total silt deposited
    (*ii*) Rate of silting

(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	
(*d*) Various measurements and observations	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	
(*iii*) Temperature measurements	
(*iv*) Seepage and regeneration	
(*e*) Fish culture	
(*f*) Anti malaria measures	
(5) Recreation facilities	
(6) Lessons to be learnt from the construction and utilisation of the dam	Earthen dams of this dimensions are as useful as more expensive masonry dams with proper care in maintenance

IX. BIBLIOGRAPHY AND HISTORICAL

(1) Historical	In 1916, at the instance of His Highness the late Maharaja, Mr. S. K. Gurtu, the then Chief Engineer of the State prepared a preliminary project for the Kaketo reservoir together with a subsidiary dam and distribution system in the Parbati river Valley for the dual purpose of irrigation and electric power supply to Gwalior. The project was then taken up for construction but all works in connection with it were suspended in 1924. After reinvestigation and revision of the scheme by Rai Bahadur S. N. Bhaduri, the construction was restarted as a purely irrigation scheme in 1927. The scheme as finally amended, comprises the following :— 1. Kaketo Reservoir supplementing the Harsi Reservoir with no independent canal system

2. Reservoir at Harsi with distribution system of Masture Canal

(2) Personnel

Mr. S. K. Gurtu was the originator of the scheme. R. B. S. N. Bahaduri was responsible for the detailed final scheme and it was completed in the supervision of Mr. A. R. Pollard in 1937. Messrs. Nethersole, Inspector General of Irrigation, India Government, H. P. Gibbs of the Tata Hydro-electric Co. and N. B. Baxter of the Bombay Presidency gave opinions on the Project in the capacity of consulting engineers.

(3) Bibliograpay

CHAPTER XI

MINOR BASINS

XI. 1. Russellkonda Dam

(Earthen)

I. GENERAL

1. Height above the lowest river bed	57·5 feet
2. Location	Madras State, Ganjam District (Boringawalla, a tributary of Mahanadi)
3. Authority or owner	Madras Government
4. Purpose—Main and subsidiary	Irrigation
5. Year of commencement	1884
6. Year of completion	1901
7. Capital cost	
(a) Estimated	
(b) Actual	
8. Culturable area commanded by the project	
9. Area irrigated	
11. Means of access	It is situated 12 miles North of the town of Russell Konda, and is accessible by road from the Berhampur railway station on the Waltair-Calcutta line, Bengal Nagpur Railway and distance by road is about 52 miles

II. GEOPHYSICAL

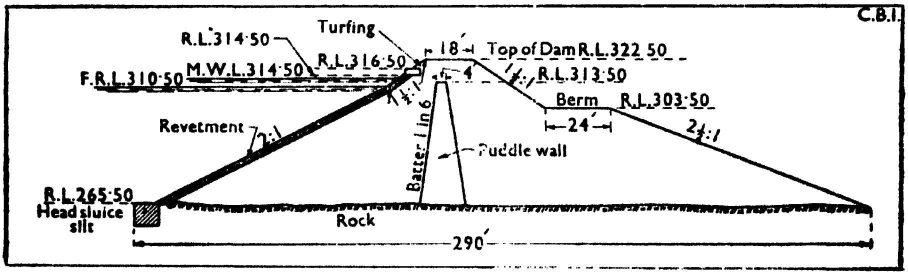
1. Area of catchment	25 square miles
2. Nature of catchment	
3. Mean annual precipitation	
(a) Rainfall	51·99 inches
(b) Snow	
4. Total average annual yield of the catchment	59·28 cusecs

5. Climate	Tropical
6. Temperature conditions and variations	Maximum temperature 119·5°F Minimum temperature 65·0°F
7. Rate of flow	
(a) Maximum	
(b) Minimum	
8. Detritus charge of the stream	There is not much of silt brought down from the catchment basin and Gulleri Channel
9. Character (chemical) of the water stored in the reservoir	The water is drinkable and soft for irrigation purposes
10. Geological features	
(a) of foundations	
(b) of catchment area	
11. Earthquake (zone and intensities)	

III. TECHNICAL

A. STATISTICAL

1. Reservoir Data	
(a) M.W.L.	R.L. 314·00
(b) F.R.L.	R.L. 310·50
(c) Area at M.W.L.	
(d) Area at F.R.L.	4·04 square miles
(e) Maximum length	
(f) Maximum width	
(g) Length of periphery	
2. Capacity of the reservoir	
(a) Gross	34·320 acre-feet
(b) Live	
(c) Flood storage	
(d) Carry-over	



Cross Section of Russell Konda Dam

3. Maximum height above the lowest point of foundations	59 feet
4. Height above the lowest river bed at dam	57·5 feet
5. Height of the top of the dam above the crest of the spillway or weir	12 feet
6. Maximum width at level of foundation	290 feet
7. Width at top	10 feet to 18 feet
8. Slopes	
(*a*) Upstream	As per sketch
(*b*) Downstream	
9. Length at top of the dam	4,300 feet
(*a*) Non overflow	
(*i*) Main	4,080 feet
(*ii*) Subsidiary	
(*b*) Spillway	220 feet
10. Cubic volume of the body of the dam	

B. OTHERS

11. Material of which the dam is constructed	Earthen *bund* with puddle wall provided in the dam, as per sketch.
12. Specific gravity	
(*d*) Earthfill	
13. Nature of protection and water proofing of the upstream and downstream faces	The upstream face revetted upto 5·5 feet above F.R.L.
14. Provision for dealing with seepage and drainage water	The seepage water is drained away from the toes of the bund by means of rough stone drains which are connected by earthen drains, till seepage water falls in lead off drainage Nalla.
15. Means of securing water tightness of the foundation of the dam	By means of puddle core wall
22. Hydraulic gradient for which the embankment is designed	
22. Particulars of the berm (if any) width and position	24 feet wide at R.L. 303·50

23. Position and form of the core wall (or other means of securing water tightness)	As per sketch
24. Batter (if any) of the core wall	1 in 6
25. Maximum depth below ground surface of corewall or other means of securing water tightness	
26. Method of keying core wall or other wall in the underlying ground	
27. Nature of material forming the core or other wall	Puddle

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DA

1. *Land submerged*
    - (*a*) Crown waste
    - (*b*) Proprietory
2. *Dislocation*
    - (*a*) Villages
    - (*b*) Families
    - (*c*) Population
    - (*d*) Roads
        - (*i*) Highways
        - (*ii*) District roads
        - (*iii*) Village roads
    - (*e*) Railway lines
    - (*f*) Temples, mosques, etc.
    - (*g*) Graves, etc.
    - (*h*) Trees, gardens, pastures, houses, wells, etc.
    - (*i*) Bridges
3. Compensation paid under each category of item (2)
4. Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

1. Surplusing works	Masonry surplus weir 220 feet long
2. Outlet works 3. Scouring works	A head sluice of 3 vents 3 feet by 6 feet high regulated by screw gearing shutters. Silt level of sluice is 265·00

4. Inspection facilities

5. Fish pass

6. Means for dissipating energy below the spillway

VIII. SUPPLEMENTARY INFORMATION

1. Constructional features	(*i*) The puddle wall originally designed with a top width of 6 feet, and batter of 1 in 8 with its top 3 feet above the M.W.L. was raised only to 2 feet above M.W.L. with a top width of 4 feet and batter of 1 in 6.
	(*ii*) Cofferdam foundations for the puddle dyke at the crossing of the stream passing through the site of the dam were restored.
	(*iii*) A perpendicular wave breaker wall 3 feet in thickness was provided above the stone revetment while gravel backing right upto the top and turfing the front slope of bund above the level was also carried out.
2. Changes introduced in the plans of the dam and in the method of carrying out the work	(*iv*) A water cushion was formed by constructing a drop in rear of the head sluice and at a distance of 400 feet from it with one *Tamboj* vent in the same at a level of 6 feet below the sill of head sluice; the crest of the drop being at the sill level of the head sluice.
	(*v*) Ball bearings have been provided later on to one shutter, and for other two are yet to be provided. An emergency shutter is also to be added to enable the ordinary shutters to be examined and repaired when there is water in the tank.

3. Noteworthy occurrences and accidents
4. Operation of the dam
    - (*a*) Regulation
    - (*b*) Silting of the reservoir
        - (*i*) Total silt deposited
        - (*ii*) Rate of silting
        - (*iii*) Density of the silt deposited
        - (*iv*) Rate of advancement of delta
    - (*c*) Actual yield as against estimated
    - (*d*) Various measurements and observations
        - (*i*) Evaporation losses
        - (*ii*) Sweating below the dam
        - (*iii*) Temperature measurements
        - (*iv*) Seepage and regeneration
    - (*e*) Fish culture
    - (*f*) Anti malaria measures
5. Recreation facilities
6. Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

1. Historical

    Major Buckley, Royal Engineer investigated the Rushi kulya project during the years 1868 to 1872 and sent his first report of investigation in September 1872. An estimate for the project was submitted to the Government of India in May 1882. It was sanctioned by Secretary of State in April 1883 and intimated by the Government of India in June 1883. Work was commenced in 1884 and completed in March 1901.

2. Personnel
3. Bibliography

XI. 2. Surada Dam

(Earthen)

I. GENERAL

1. Height above the lowest river bed	45 feet
2. Location	Ganjam District, Orissa State (Padma River)
3. Authority or owner	Orissa Government
4. Purpose Main and subsidiary	Irrigation
5. Year of commencement	1884
6. Year of completion	1902
7. Capital cost	
(*a*) Estimated	Rs. 4,26,200
(*b*) Actual	
8. Culturable area commanded by the project	
9. Area irrigated	
10. Installed hydroelectric capacity	
(*a*) Firm	
(*b*) Secondary	
11. Means of access	The Surada Dam is 47 miles distant and is accessible by road from the Berhampur Railway Station (Waltair—Calcutta Line, Bengal Nagpur, Railway)

II. GEOPHYSICAL

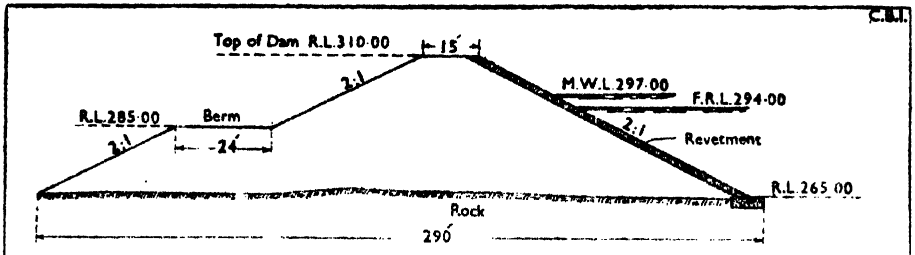
1. Area of catchment	200 square miles
2. Nature of catchment	
3. Mean annual precipitation	
(*a*) Rainfall	54·90 inches
(*b*) Snow	Nil
4. Total average annual yield of the catchment	34,435 acre feet
5. Climate	Tropical

6. Temperature conditions and variations	Maximum 119·5°F Minimum 65·0°F.
7. Rate of flow	
(a) Maximum	
(b) Minimum	Nil
8. Detritus charge of the stream	A large quantity of silt is being carried down by the river, brought from the proximity of hills to the reservoir.
9. Character (chemical) of the water stored in the reservoir	Potable and safe
10. Geological features	
(a) of foundations	
(b) of catchment area	
11. Earthquake (zone and intensities)	

III. TECHNICAL

A. STATISTICAL

1. Reservoir Data	
(a) M.W.L.	R.L. 297·00 (from an arbitrary datum)
(b) F.R.L.	R.L. 294·00 (from an arbitrary datum)
(c) Area at M.W.L.	
(d) Area at F.R.L.	3·03 square miles
(e) Maximum length	
(f) Maximum width	
(g) Length of periphery	
2. Capacity of the reservoir	
(a) Gross	
(b) Live	28,505 acre feet
(c) Flood storage	
(d) Carry-over	



Cross Section of Surala Dam

3. Maximum height above the lowest point of foundations	
4. Height above the lowest river bed at dam	45 feet
5. Height of the top of the dam above the crest of the spillway or weir	16 feet
6. Maximum width at level of foundation	237 feet (approximately)
7. Width at top	8—15 feet
8. Slopes	
(a) Upstream	2 : 1
(b) Downstream	2 : 1
9. Length at top of the dam	19,800 feet
(a) Non overflow	
(i) Main	18,168·5 feet
(ii) Subsidiary	
(b) Spillway or waste weir	1631·5 feet
10. Cubic volume of the body of the dam	

B. OTHERS

11. Material of which the dam is constructed	Earth
12. Specific gravity	
(d) Earthfill	
13. Nature of protection and water proofing of the upstream and down-stream faces	
14. Provision for dealing with seepage and drainage water	Small earthen bunds have been provided downstream of the dam to drain seepage water away from the toe of the bund
15. Means of securing water tightness of the foundation of the dam	
21. Hydraulic gradient for which the embankment is designed	
22. Particulars of the berm (if any) width and position	15-32 feet wide berm on downstream side 25 feet below the top of the dam at R.L. 285·00
23. Position and form of the core-wall (or other means of securing water tightness)	

24. Batter (if any) of the core-wall

25. Maximum depth below ground surface of core-wall or other means of the securing water tightness

26. Method of keying core-wall or other wall in the underlying ground

27. Nature of material forming the core or other wall

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory

(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads
    (*i*) Highways
    (*ii*) District roads
    (*iii*) Village roads
  (*e*) Railway lines
  (*f*) Temples, mosques, *etc.*
  (*g*) Graves, *etc.*
  (*h*) Trees, gardens, pastures, houses, wells, *etc.*
  (*i*) Bridges

(3) Compensation paid under each category of item (2)

(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

1. Surplusing works	Padma river weir 424·5 feet long and Borida river weir, 1,205 feet long
2. Outlet works	A head sluice of 4 vents 3 feet × 6 feet high regulated by screw gearing shutters
3. Scouring works	Padma Scouring sluices No. 6, 8 feet × 8½ feet

4. Inspection facilities	
5. Fish pass	
6. Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

1. Constructional features	
2. Changes introduced in the plans of the dam and in the method of carrying out the work	The dam was strengthened considerably under the third revised estimate. In 1900 during flood days the surplus weir 120 feet long breached, and after that the whole length of the body wall for a depth of 10 feet from the crest was demolished and rebuilt to a stronger section. The approaches to the weir were also very much enlarged to increase its efficiency A second weir 500 feet long at the right flank of the dam and above the Padma crossing, the discharge capacity of which is 16,000 cusecs, was also added in order to reduce the surface fall of 2¼ feet observed during the floods of 1900 between the head sluice and the weir at the left flank and also to afford timely relief to the reservoir in times of sudden floods One of the tributaries (the Johero river), had to be excluded from the reservoir catchment, owing to the deep and sandy subsoil of the river bed at site. Consequently the east bund of the reservoir had to be diverted so as to cross the Padma river only The opening of the head sluice to the full height of 5 feet in 1900 and the consequent washing out of the rear revetment and apron etc., in rear of the head sluices wanted subsequent improvements to head sluice extending barrel wings, rear floor, etc. of head-sluice

During the construction it was experienced that soil being used is of weak nature and that was replaced by hard red earth

In the year, 1900, the surplus weir went under a breach 120 feet long during flood days. And this breach made a great change in its slope and was rebuilt to stronger section

Many slips occurred in the east bund due to the weak nature of the soil used during construction

3. Noteworthy occurrences and accidents

4. Operation of the dam
   - (*a*) Regulation
   - (*b*) Silting of the reservoir
     - (*i*) Total silt deposited
     - (*ii*) Rate of silting
     - (*iii*) Density of the silt deposited
     - (*iv*) Rate of advancement of delta
   - (*c*) Actual yield as against estimated
   - (*d*) Various measurements and observations
     - (*i*) Evaporation losses
     - (*ii*) Sweating below the dam
     - (*iii*) Temperature measurements
     - (*iv*) Seepage and regeneration
   - (*d*) Fish culture
   - (*f*) Anti malaria measures

5. Recreation facilities — None

6. Lessons to be learnt from the construction and utilisation of the dam

IX. BIBLIOGRAPHY AND HISTORICAL

(1) **Historical**

(2) **Personnel**

(3) **Bibliography**

XI. 3. Muwalia Dam

(Earthen)

I. GENERAL

(1) Height above the lowest river bed	53 feet
(2) Location	Panchmahals District, Bombay State (Dadhumati River)
(3) Authority or owner	Bombay Government
(4) Purpose—Main and subsidiary	Irrigation
(5) Year of commencement	1900
(6) Year of completion	1910
(7) Capital cost	
(*a*) Estimated	Rs. 3,81,220
(*b*) Actual	Rs. 3,70,712
(8) Culturable area commanded by the project	3,000 acres
(9) Area irrigated	2,000 acres
(11) Means of access	It is situated 3 miles away from Dohad railway station on Bombay Baroda and Central India Railway. A metalled road connects the Dam to Dohad

II. GEOPHYSICAL

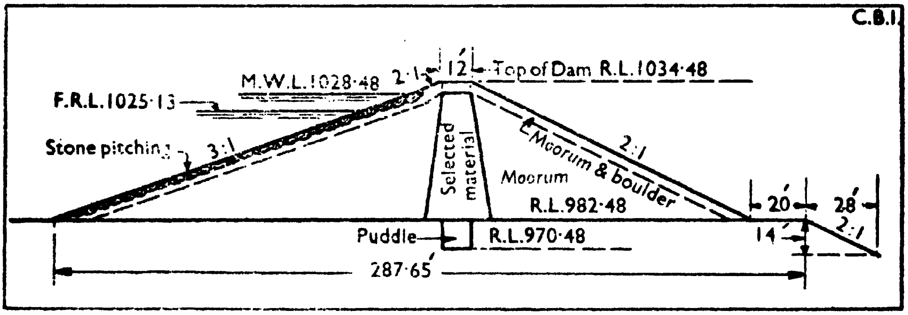
(1) Area of catchment	30 square miles
(2) Nature of catchment	Hilly tracts with valleys and cultivation only on low lands.
(3) Mean annual precipitation	
(*a*) Rainfall	30 inches
(4) Total average annual yield of the catchment	7,300 acre feet
(5) Climate	
(6) Temperature conditions and variations	Maximum 108°F and Minimum 36°F

(7) Rate of flow	
(a) Maximum	
(b) Minimum	
(8) Detritus charge of the stream	
(9) Character (chemical) of the water stored in the reservoir	Soft water. Sweet and fit for irrigation purpose.
(10) Geological features	
(a) of foundations	Hard *moorum* with disintegrated soft rock
(b) of catchment area	Earth and *moorum*

III. TECHNICAL

A. STATISTICAL

(1) Reservoir data	
(a) M.W.L.	R.L. 1028·48
(b) F.R.L.	R.L. 1025·13
(c) Area at M.W.L.	
(d) Area at F.R.L.	0·678 square mile
(e) Maximum length	
(f) Maximum width	
(g) Length of periphery	
(2) Capacity of the reservoir	
(a) Gross	
(b) Live	5,441 acre feet
(c) Flood storage	
(d) Carry-over	



Cross Section of the Muwalia Dam

(3) Maximum height above the lowest point of foundations	64 feet
(4) Height above the lowest river bed at dam	53 feet

(5) Height of the top of the dam above the crest of the spillway or weir	9·35 feet
(6) Maximum width at level of foundation	287·65 feet
(7) Width at top	12·0 feet
(8) Slopes	
(*a*) Upstream	3 to 1 and 2 to 1
(*b*) Downstream	2 to 1
(9) Length at top of the dam	
(*a*) Non-overflow	
(*i*) Main	970 feet
(*ii*) Subsidiary	270 feet
(*b*) Spillway or waste weir	High crest weir 100 feet Clear over fall weir 758 feet
(10) Cubic volume of the body of the dam	8,930,000 cubic feet

B. OTHERS

(11) Material of which the dam is constructed	Selected material for hearting and *moorum* casing on both sides The outer slopes are covered with *moorum* and boulder and in add tion inner slope is provided with dry stone pitching upto M.W.L.
(12) Specific gravity	
(*d*) Earthfill	
(13) Nature of protection and waterproofing of the upstream and downstream faces	Dry stone revetment only on upstream side
(14) Provision for dealing with seepage and drainage water	
(15) Means of securing water tightness of the foundation of the dam	By means of puddle core wall
(21) Hydraulic gradient for which the embankment is designed	
(22) Particulars of the berm (if any) width and position	20 feet berm on the outside with 2 to 1 slope
(23) Position and form of the core-wall (or other means of securing water tightness)	As per cross section
(24) Batter (if any) of the core-wall	As per cross section
(25) Maximum depth below ground surface of core-wall or other means of securing water tightness	12 feet

(26) Method of keying core-wall or other wall in the underlying ground	By means of puddle trench
(27) Nature of material forming the core or other wall	Selected material and puddle trench

IV. PREPARATION FOR SUBMERGENCE OF AREA ABOVE THE DAM

(1) *Land submerged*
  (*a*) Crown waste
  (*b*) Proprietory
(2) *Dislocation*
  (*a*) Villages
  (*b*) Families
  (*c*) Population
  (*d*) Roads
    (*i*) Highways
    (*ii*) District roads
    (*iii*) Village roads
  (*e*) Railway lines
  (*f*) Temples, mosques, etc.
  (*g*) Graves, etc.
  (*h*) Trees, gardens, pastures, houses, wells, etc.
  (*i*) Bridges
(3) Compensation paid under each category of item (2)
(4) Method of compensating for land of dispossessed landholders

V. AUXILIARY WORKS

(1) Surplusing works	The waste-weir consists of :— (*a*) High crest wall 100 feet wide and (*b*) clear overfall weir 758 feet wide. The total designed discharge of 14,000 cusecs is passed down in two channels one on the right is a natural channel and the other on the left is a built up one, consisting of collecting chambers, and a cement concrete chute fall 40 feet wide with a bed slope of 1 in 12·5,

(2) Outlet works	Head regulator with circular masonry wall eight feet diameter, and double gates for right bank canal and head regulator with circular masonry wall five feet diameter with double gates for left bank canal.
(3) Scouring works	
(4) Inspection facilities	
(5) Fish pass	
(6) Means for dissipating energy below the spillway	

VIII. SUPPLEMENTARY INFORMATION

(1) Constructional features	The dam is in two parts at right angles to each other, one part is across the main course of the stream and the other one closes the depression with a hillock intervening on one side. There is a puddle core wall 12 feet deep and 10 feet wide below the dam. The hearting consists of selected earth with *moorum* covering on both sides.
(2) Changes introduced in the plans of the dam and in the method of carrying out the work	
(3) Noteworthy occurrences and accidents	
(4) Operation of the dam	
(*a*) Regulation	
(*b*) Silting of the reservoir	
(*i*) Total silt deposited	
(*ii*) Rate of silting	
(*iii*) Density of the silt deposited	
(*iv*) Rate of advancement of delta	
(*c*) Actual yield as against estimated	
(*d*) Various measurements and observations	
(*i*) Evaporation losses	
(*ii*) Sweating below the dam	

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